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THE

GEOLOGY

AND

PALAEONTOLOGY

OF THE

CLYDE DRAINAGE AREA:

BEING THE GEOLOGICAL PORTION OF
THE NATURAL HISTORY HANDBOOK ISSUED FOR
THE MEETING OF THE BRITISH ASSOCIATION
IN GLASGOW, SEPTEMBER, 1901;
AND RE-ISSUED FOR THE MEMBERS OF THE
GEOLOGICAL SOCIETY OF GLASGOW,
WITH CORRECTIONS AND ADDITIONS.

EDITED BY

JAMES BARCLAY MURDOCH, F.R.Ph.S.E.,
Hon. Secretary of the Geological Society of Glasgow.

GLASGOW:
PUBLISHED AT THE ROOMS OF THE GEOLOGICAL SOCIETY,
207 BATH STREET.

1904.

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INTRODUCTORY NOTE

To the Re-issue of the Geological portion of the "Handbook."

In issuing a "Handbook" of the Fauna, Flora, and Geology of the Clyde Area, for the Meeting of the British Association in Glasgow in September, 1901, the Local Committee was fortunate enough to obtain the assistance of many of the leading Scottish workers in the various branches of natural science, the geological articles being largely contributed by members of the Geological Society of Glasgow.

After the affairs of the Meeting were wound up, the whole of the remaining copies of the "Handbook" were kindly presented by the Local Committee to the Geological Society and the Natural History Society, and it was arranged that the sheets should be divided, each Society binding up the articles on its respective subjects, for the use of its members.

The following pages will therefore be found to contain all the matter in the "Handbook" relating to the Geology and Palaeontology of the Clyde Drainage Area, and it is hoped that they may for many years be found useful to students of those branches of science.

For the convenience of those who may wish to make additions to the lists, a number of copies have been interleaved.

The Editor.

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NOTES AND CORRECTIONS TO THE "HANDBOOK."

During the printing of the "Handbook," very little time having been available for the purpose, great difficulty was experienced in the revision of the proof sheets, and consequently various errors escaped notice until too late. Several of the more important are here pointed out:—

Original Preface, page xii.

"When twenty-five years ago [1876] the British Association "met in Glasgow a Natural History Handbook dealing with "the Fauna, Flora, and Geology of the district was issued to the "members. Owing to various circumstances—the chief of which "were the paucity of workers and the short time available for "the work—the lists were far from covering the whole ground, "and by no means free from errors."

These statements are, however, founded on an entire misapprehension of the case, and should not have been made. The Geological Handbook of 1876 was issued as an entirely separate and distinct publication from the Natural History one, and, whatever might be said as to the defects of the latter, the above remarks are in no way applicable to the "*Catalogue of the Western Scottish Fossils*,"* which was a most creditable and reliable work, by the best authorities on the subject, and one which, during the long period which has elapsed since its issue, has served as a reliable guide to Western Scottish Geology and Palaeontology, and is not obsolete even at the present day.

Prefatory Note to Geology, page 399, line 11.

For "John Armstrong" read "James Armstrong."

---

* "*Catalogue of the Western Scottish Fossils*," compiled by James Armstrong, John Young, F.G.S., and David Robertson, F.G.S. With Introduction on the Geology and Palaeontology of the District, by Professor Young, M.D. [With a Sketch Map of the District surrounding Glasgow, by James Grahame. Printed for the Local Executive Committee of the British Association.] Glasgow, 1876.

Millstone Grit Series, top of page 467.

Two lines in this paragraph have been transposed, making nonsense of the sentence. It should read as follows:—

"MILLSTONE GRIT SERIES.

"The Officers of the Geological Survey have introduced this series into their Maps and Memoir, and have for this purpose drawn the base of the Upper Coal and Ironstone series at the slatyband ironstone. But not having detected it in the Kilwinning district, they seem to have come to the conclusion that there is no Millstone Grit in that area. However, the slatyband ironstone does occur in an open section on the east side of Lugton Water, below Sevenacres Mill, and was also worked at Moncur."

Carboniferous Corals, page 480, line 19.

For "Protocyatohphyllum" read "Protocyathophyllum."

Conodonts, page 510, line 2.

For "Pander" read "Pander of Russia."

Drift, page 524, line 9.

For "actinolite" read "actinolite rock."

Drift, page 524, line 11.

For "from underdrift" read "from under drift."

Post-Drift Fossils (Vertebrata), page 544, line 8.

Delete the asterisk (*) after "*Homo sapiens*, broken bones," as none of these have been found at Cleaves Cove, Dalry.

ADDITIONS TO LISTS IN THE "HANDBOOK."

By John Smith.

Carboniferous Corals, by the late James Thomson, F.G.S., page 480.

Authorities—"Memoirs" of the Geological Survey; "Catalogue of the Western Scottish Fossils, 1876;" Papers and Specimens in the James Thomson Collection, Kilmarnock Museum; John Smith's own observations.

Aulopora gigantea (*M'Coy*), Auchenskeith, Dalry.
Protocyathophyllum contortus (*T.*), Cunningham-Baidland.
,, serratus (*T.*), ,, ,,
Chaetetes dubius (*M'Coy*), Hawkhill, Stevenston.
Michelinia favosa (*Goldf.*), Auchenskeith, Dalry.
Alveolites capillaris (*Ph.*), Asheyburn, Muirkirk.
,, septosa (*E. & H.*), ,, ,,
Amplexus irregularis (*Thomson*), Roughwood, Beith.
,, minutus (*T.*), ,, ,,
Zaphrentis cylindrica (*Scouler*), Kennox Water, Douglas.
,, cyathina (*de Kon.*), Brockley.
,, Griffithi (*M. Edw.*), Netherfield, Strathavon.
,, Murchisonia (*T.*), High Blantyre.
,, Michelini (*E. & H.*), Netherfield, Strathavon.
,, nodulosus (*Ph.*), Brockley.
,, pachysepta (*T.*), Auchenskeith, Dalry.
Heterophyllia angulata (*Dun.*), Brockley.
,, granulata (*Dun.*), ,,
,, grandis (*M'Coy*), Gameshill, Stewarton.
Campophyllum Armstrongi (*T.*), Brockley.
,, cyathica (*E. & H.*), Auchenskeith, Dalry.
,, cylindrica (*E. & H.*), ,, ,,
,, furcilatum (*T.*), Cunningham-Baidland.
,, giganteum (*T.*), Rye Water, Dalry.
,, sinuosum (*T.*), Auchenskeith, Dalry.
,, subpalmatum (*T.*), Brockley.
Lithostrotion basaltiforme (*Fl.*), Cunningham-Baidland.
,, decipiens (*M'Coy*), Boghead, Lesmahagow.
,, irregulare (*Ph.*), Beith; Dalry.

Fasciculophyllum Duboyeski (*T.*), Brockley.
Diphyphyllum approximatum (*T.*), Langside, Beith.
  „ fasciculatum (*D'Orb.*), Boghead, Quarter.
  „ furcatum (*T.*), Marnock Water.
Clisiophyllum Danianum (*T.*), Thirdpart, Beith.
Aspidophyllum obovatum (*T.*), Langside, Beith.
  „ Scoticum (*T.*), „ „
Dibunophyllum approximatum (*T.*), Corrieburn, Kilsyth.
  „ fasciculatum (*Fl.*), Boghead, Lesmahagow.
  „ M'Chesneyi (*T.*), Brockley.
  „ splendens (*N. & T.*), Langside, Beith.
Cymatophyllum octolamellum (*T.*), „ „
Cyclophyllum frondicum (*T.*), Gameshill, Stewarton.
Cyathophyllum cuspidophyllum (*T.*), Brockley.
  „ giganteum (*Mich.*), „
  „ regium (*Ph.*), Gateside, Beith.
  „ robustum (*T.*), Roughwood, Beith.
  „ Stuchburyi (*M. Edw.*), Shiels.
  „ Ureanum (*T.*), Cunningham-Baidland.
Cyathopsis cornu-bovis (*Mich.*), Auchenskeith, Dalry.
Mortiera vertebralis (*de Kon.*), Cunningham-Baidland.
Palaecis compressa, *var.* irregulare (*R. E., jun.*), Gare, Carluke.
  „ cyclostoma (*Ph.*), Auchenskeith, Dalry.
Syringopora distans (*Fisch.*), Boghead, Lesmahagow.
  „ gigantea (*T.*), Langside, Beith.
  „ laxa (*Ph.*), Asheyburn, Muirkirk.
  „ ramulosa (*Goldf.*), Howwood; Broadstone.
  „ reticulata (*T.*), Boghead, Lesmahagow.

Miscellaneous Carboniferous Fossils.

Egg-Cases of Sharks, ?
  Authority—R. Kidston, F.R.S., *Proc. Roy. Phys. Soc. Edin.*, Vol. IX.; and John Smith.
Palaeoxyris helicteroides (*Morris*), U.C.S., Kilmaurs.
  „ carbonaria (*Sch.*), „ „

Thought by some geologists to be Plant-remains, by others, Egg-cases of Sharks. The beds they occur in are evidently of freshwater origin.

Footprints—probably of Labyrinthodonts—in the Calciferous Sandstone, near West Kilbride.

Authority—John Smith, *Trans. Geol. Soc. of Glasgow*, Vol. IX., p. 201.

Annelida.

Authority—John Smith.

Staurocephalites, sp., L.L.S., Auchenskeith, Dalry.

Authorities for the following—"Memoirs" of the Geol. Survey for Ayrshire and Lanarkshire; *Trans. Geol. Soc. of Glasgow*, Vol. II.; "Catalogue of Western Scottish Fossils, 1876;" *Geol. Mag.* for 1887, 1899.

Macrura.

Anthrapalaemon Grossarti (*Salter*), U.I.S., Airdrie.
„ glaber (*Jones & Woodw.*), U.C.S., Kilmaurs.

Stomopoda.

Pygocephalus Cooperi (*Huxley*), U.C.S., Kilmaurs.
„ Huxleyi (*Woodw.*), L.I.S., Paisley.

Trilobita.

Phillipsia Eichwaldi (*Fisch.*), U. and L.L.S., Dalry.
„ globiceps (*Portl.*), Main Limestone, Carluke.
„ mesotuberculatus (*M'Coy*), U.L.S., Dalry.

Phyllopoda.

Cyclus Rankini (*Scouler*), First Calmy Limestone, Carluke.

Merostomata.

Belinurus trilobitoides (*König & Buckl.*), U.C.S., Kilmaurs.
Eurypterus Scouleri (*Hibbert*), Kirkton Quarry.
„ „ skin, in underclays of coal-beds.
Prestwichia rotundata (*Woodw.*), U.C.S., Kilmaurs.

Orthoptera.

Etoblattina Peachii (*Woodw.*), U.C.S., Kilmaurs.

Myriopoda.

Euphoberia Browni (*Woodw.*), U.C.S., Kilmaurs.
Xylobius sigillariae (*Dawson*), „ „

Arachnida.

Eoscorpius, sp. (*Meek & Worthen*), Gillfoot, Carluke.
Scorpion Remains, abundant in the coal-beds and underclays.

[*Original Title-page to the "Handbook."*]

FAUNA, FLORA & GEOLOGY

of the Clyde Area

EDITED BY

G. F. SCOTT ELLIOT

MALCOLM LAURIE

AND

J. BARCLAY MURDOCH

Glasgow
Published by the Local Committee for the
Meeting of the British Association
1901

[*Original Preface to the "Handbook."*]

PREFACE.

When twenty-five years ago the British Association met in Glasgow a Natural History Handbook dealing with the Fauna, Flora, and Geology of the district was issued to the members. Owing to various circumstances—the chief of which were the paucity of workers and the short time available for the work—the lists were far from covering the whole ground, and by no means free from errors. It was felt by many Naturalists of the District that the present meeting of the British Association afforded an opportunity for repairing many of the errors and omissions of the former Handbook, and for bringing to a focus the very large amount of work which has been done of late years in the Clyde area. It is not to be supposed that the present volume professes either to be a complete record or to be free from errors. The size of the volume and the speed with which it had to be put through the press render it certain that many errors have escaped correction, and a cursory inspection of the contents will reveal that many groups are not treated of, while others have only been studied during the last three years, *i.e.*, since the idea of this Handbook was first mooted. It is to be hoped that the blanks will be as valuable for the future work in the district as the comparatively complete lists, inasmuch as they will show local workers on what groups they may most profitably concentrate their attention.

The Editors feel that this Handbook should not go out without an expression of its indebtedness to all concerned in its production. This number includes, in addition to the compilers, the great majority of the working Naturalists of the district and many eminent scientific men throughout the Kingdom, for each and all have freely placed the information in their possession at the service of those responsible for the various sections of the Handbook, and spared no pains to make the volume worthy of the meeting for which it has been prepared.

While those who have worked for this volume directly and indirectly are too numerous to thank individually, special mention of services done is due in two cases. The first is the Secretary of the original Committee, the Rev. G. A. Frank Knight, M.A., F.R.S.E., to whose enthusiasm and power of organisation a great part of the success of the volume is due. The second is the printers of the volume, Messrs. MacLehose, whose courtesy, care, and promptitude in carrying through a very difficult piece of work under trying circumstances none but the Editors can fully appreciate.

THE GEOLOGY AND PALAEONTOLOGY
OF THE
CLYDE DRAINAGE AREA.

PREFATORY NOTE.

BY J. B. MURDOCH, F.R.PH.S.E.

THE West of Scotland has for a long time been fortunate in possessing an active number of workers in Geological and Palaeontological science, and much of the outcome of their labours during the last fifty or sixty years has been made available to the public through the *Transactions* of the Natural History Society, and those of the Geological Society of Glasgow.

The first attempt to consolidate the many lists and papers on local geology resulted in the publication of "The Carboniferous Fossils of the West of Scotland, by (Dr.) John Young, with a General Catalogue of the Fossils by James Armstrong," which was issued in 1871.[1]

This book again formed the nucleus of the more exhaustive "Catalogue of the Western Scottish Fossils," compiled by John Armstrong, John Young, F.G.S., and David Robertson, F.G.S., which was published as a local guide-book for the use of the members of the British Association, whose meeting was held in Glasgow in 1876. The editors were largely assisted in its articles by other workers in field and study work, and to such good purpose that the "Catalogue" has up to the present day served as a reliable guide to the Geology of the West of Scotland, and is by no means even yet superseded.

The following Geological portion of the "Handbook" for the British Association meeting of 1901 has been drawn up on somewhat similar lines to those of the former volumes, the various articles in it beginning with the lowest formation represented in the area and gradually ascending to the most recent. A glance at its pages will show that the contributors are worthy successors of the men who preceded them.

Preparations for the work were begun some years ago, and it is unfortunately the case that a number of those who promised to contribute died before they were able to carry out their intentions, or at least did not survive to revise and correct the articles in print, so that these have had either to be supplied by other hands, or at least have not had the benefit of the author's supervision.

Amongst these deceased gentlemen may be mentioned Dr. John Young, F.G.S., to whose work and efforts the cause of Western Scottish geological investigation must ever owe a debt of gratitude; Dr. David Robertson, F.G.S., and Dr. Crosskey, F.G.S., his coadjutor in the investigation of the Clyde Post-tertiary beds; James Thomson, F.G.S., known generally as "Coral" Thomson, for his laborious work in connection with that group; Robert Craig, of Beith, an ardent worker in the Carboniferous Limestones of Ayrshire; Dugald Bell, F.G.S. an enthusiast in the study of geological glacial phenomena; James Bennie, of the Geological Survey, whose investigations, more especially in connection with "Surface Geology," have been of great importance; and Mr. James W. Kirkby, of Leven, Fifeshire, an authority upon all connected with the Carboniferous rocks, whose death occurred only within the last few weeks.

---

[1] *Transactions of the Geological Society of Glasgow*, vol. iii., supplement, 1871.

In conclusion it may be added that though the nomenclature of many of the genera and species will be found to be altered from that of the 1876 Catalogue there is much in that volume which has not been superseded in the present Handbook. The attention of students may therefore still be directed to it for much interesting matter.

THE GEOLOGY OF THE CLYDE TERRITORY.

By J. Horne, F.R.S.

This district embraces the natural drainage area of the River Clyde and of the sea-lochs that form extensions of its estuary. Northwards the boundary line is defined by the mountains round the head of Loch Fyne and Loch Lomond; eastwards by the watershed between the Clyde and the rivers flowing east to the German Ocean; and southwards by a line drawn from the Mull of Kintyre to the southern point of Ayrshire. It thus comprises a broad belt of crystalline schists extending from Loch Lomond to the Mull of Kintyre, a portion of the Silurian tableland of the Southern Uplands and a great development of Old Red Sandstone and Carboniferous strata occupying the western part of the Central Lowlands.

The southern limit of the crystalline schists of the southwest Highlands is defined, between Loch Lomond and Toward Point south of Dunoon, by powerful faults which let down the Old Red Sandstone on the southeast side. Immediately to the north of this fault, between Loch Lomond and Callander, there is a narrow belt of strata, provisionally correlated with the Arenig rocks of the south of Scotland, including hornblende-schists, chlorite-schists, cherts, black shales and grits. Similar strata have been recently identified by Mr. Gunn of the Geological Survey in North Glen Sannox, Arran, and they have been traced at intervals along the Highland border by Messrs. Barrow, Dakyns, and Clough, to Forfarshire and Kincardineshire. In Arran the green rocks of igneous origin comprise lavas, volcanic agglomerates and intrusive masses which recall petrological types of the Arenig igneous rocks in Ayrshire. Both in Arran and in the Kelty Water near Callander these strata are considerably deformed; the igneous rocks have been rendered schistose, the black shales are cleaved, the cherts have been granulitised, and the grits show flaser structure. Though the black shales have yielded impressions which simulate the appearance of graptolites, it must be frankly stated that no fossils have been obtained from these rocks which prove their age. In Forfarshire, Radiolaria have been found in the cherts, and certain rounded bodies have been detected in the same rocks in the Callander region which may prove to be traces of these organisms. The relation of these presumably Silurian rocks to the schistose grits of the Highlands, both near Loch Lomond and in Arran, is still uncertain. In Forfarshire and Kincardineshire Mr. Barrow of the Geological Survey has drawn a reversed fault between the two, but no such line of displacement has yet been detected in the southwest Highlands. Indeed the boundary line must be regarded as a provisional one in the Callander district and in Arran.

To the north of the belt of strata just described there is an important development of altered sedimentary rocks forming the crystalline schists of the Eastern Highlands. The various subdivisions are arranged in a definite order, but it is uncertain whether it indicates the original sequence of deposition. In the Loch Lomond district and in the western part of Perthshire the groups are met with in apparent descending order as given below :

10. Blair Atholl limestone and black schists.
9. Quartzite.
8. Graphitic schist with thin lenticular bands of limestone, clay-slate, and calcareous sericite-schist.
7. Garnetiferous mica-schist.
6. Loch Tay limestone.
5. Mica-schists with sills of epidiorite.
4. Schistose epidotic grits (green beds).
3. Ben Ledi grits.
2. Aberfoyle slates, with subordinate bands of grit.
1. Leny and Aberfoyle grits.

In Cowal and the district round the head of Loch Fyne, further subdivisions of the crystalline schists have been introduced by the Geological Survey which need not here be given. It is sufficient to state that the groups met with in Perthshire have been identified and traced across the county of Argyll. For example, the Dunoon grits and phyllites are evidently the prolongations of the grits and slates at Aberfoyle ; the Ben Ledi grit group is largely represented in Cowal and in Kintyre : the green beds (No. 4), mica-schists (No. 5), and the Loch Tay limestone (No. 6) have been traced westwards from the head of Glen Fyne by Glendaruel to Loch Tarbert, and they reappear to the north of Campbeltown. The higher groups (Nos. 8, 9, 10) are evidently represented by the Ardrishaig phyllites and Loch Awe series, the latter comprising limestones, black slates, grits, and quartzites.

There can be little doubt that most of these rocks were originally sedimentary deposits, for in many instances the original clastic grains may still be recognised. Annelid tubes have been detected in the quartzites of Jura and Islay (No. 9) ; similar structures were detected by the late Duke of Argyll in quartzose-schists near Inveraray, and Mr. Macnair, of the Glasgow Geological Society, has detected what he believes to be worm-casts in certain schists apparently above the Loch Tay limestone. The geological age of these eastern Highland schists (the Dalradian series of Sir A. Geikie) still remains to be determined. These sedimentary rocks have been subjected to a regional metamorphism which cannot be attributed to any intrusion of igneous rocks now visible at the surface. Indeed Mr. Clough and Mr. Hill, of the Geological Survey, have been led to believe that in the Cowal area the metamorphism increases in intensity from the southeast and from the northwest towards a central anticline of foliation trending in a northeast and southwest direction.

These crystalline schists are pierced by igneous rocks belonging to different geological periods. One group, which is older than the regional metamorphism of the sedimentary rocks, comprises gabbro, epidiorite, and hornblende-schists ; the other set is later than this metamorphism, and is represented by various igneous masses, as, for example, the plutonic rocks of Garabal Hill near the head of Loch Lomond, and the numerous sheets and dykes of acid igneous materials (quartz-porphyries and porphyrites) in the neighbourhood of Loch Fyne, and in other districts.

The geological structure of the Silurian tableland of the Southern Uplands is extremely complicated, due partly to the non-fossiliferous character of many of the strata, partly to the inversion of the rocks over wide areas, and partly to the variation in the types of sedimentation ranging from oceanic to shallow-water and shore conditions. The true order of succession has been demonstrated by Professor Lapworth, who, by means of the vertical distribution of the graptolites, furnished a clue to unravel the stratigraphy of the whole region. As a result of the detailed examination of the tableland, it may be stated that the evidence points to continuous sedimentation from Arenig to Ludlow and Downtonian time, save in the northwest region where local unconformabilities occur.

The northwest portion of the Silurian tableland embraced in the Clyde territory furnishes striking proof of the lateral variation of the Silurian strata as the observer passes from the central Moffat region northwestwards to Leadhills and Girvan. The land from which the sediment was derived lay to the north, and hence there is a gradual increase in the thickness of several divisions of the Silurian system as we approach the Girvan area. One prominent rock-group preserves, with rare exceptions, its uniform lithological characters throughout the uplands. It consists of cherts and mudstones partly of Upper Arenig and partly of Lower Llandeilo age, which, where not deformed or altered by intrusive igneous masses, are richly charged with Radiolaria. The mudstones contain hingeless brachiopods and other organisms. The cherts, which have been formed from a true radiolarian ooze, and the mudstones, imply an oceanic phase of sedimentation. Their age is clearly defined, for throughout the uplands, where exposed on anticlinal folds, they are overlain by the Glenkiln shales with graptolites of Upper Llandeilo age; and they rest on volcanic rocks containing, in the Girvan area, cherty mudstones and graptolitic shales, yielding Middle Arenig graptolites (see general Table of Silurian strata, pp. 424, 425).

By far the greatest development of the Arenig volcanic rocks occurs near Ballantrae, where they consist of diabase and diabase-porphyrite lavas, agglomerates and tuffs, pierced by various plutonic masses, including serpentine, gabbro, dolerite, and granite. But they reappear on numerous anticlines between Abington and Leadhills in Upper Clydesdale, where they are overlain by the Radiolarian cherts and Glenkiln-Hartfell black shales.

The subdivisions of the Moffat series, established by Professor Lapworth in the central portion of the tableland: viz. Glenkiln shales (Upper Llandeilo), Hartfell shales (Caradoc), and Birkhill shales (Llandovery), imply conditions of deposition near the verge of sedimentation, for they consist of alternations of black shales, cherty bands and mudstones with rare intercalations of coarser sediment. The total thickness of these divisions of the Silurian system in the Moffat region does not exceed 300 feet, and when traced northwest to the limit of the tableland they are represented in the Girvan region by upwards of 5000 feet of strata (see general Table of Silurian rocks, pp. 424, 425). These lateral variations may thus be briefly summarised. Northwards from the central Moffat area the Birkhill shales are gradually replaced by coarser sediments, till along the northern margin of the Tarannon belt they are represented by grits, greywackes, and shales with thin carbonaceous seams yielding dwarfed representatives of Lower Birkhill graptolites. In like manner in the northern area, the Hartfell black shales undergo a similar change, and their characteristic graptolites appear, either in thin black seams interleaved in flaggy shales, or in dark sandy shales. The barren mudstones of the central Moffat region are represented in the Leadhills region by grey and blue micaceous shales (Lowther shales), greywackes and grits, with lenticular masses of limestone, which at Wrae and Glencotho are associated with volcanic rocks. Similarly the Glenkiln shales lose their normal lithological characters in the northern belt, and their characteristic graptolites are found in thin dark seams in sandy shales, interbedded with greywackes and shales.

In the Girvan region these lateral modifications of the strata are more strongly marked, as shown by Professor Lapworth, for the Moffat series is there represented by a vast thickness of conglomerates, grits, greywackes, flagstones, shales, mudstones and limestones (Barr series, Ardmillan series, Newlands series of Lapworth, see p. 429). To the north of the valley of the

Stinchar, in the Girvan and Ballantrae region, the foregoing divisions of the Silurian system rest unconformably on an eroded platform of Arenig volcanic rocks. South of the Stinchar valley this unconformability disappears, and the sequence resembles that found in the western part of the northern belt. In view of the fossil evidence it has been inferred that this break in the geological record north of the Stinchar valley took place in Upper Llandeilo time. The order of succession and subdivisions of the fossiliferous rocks of Girvan, ranging from the close of the Llandeilo period to Wenlock time, are given in the sequel (p. 429).

Along the southern margin of the tableland and beyond the limits of the Clyde territory the Tarannon rocks of the central belt pass conformably upwards into Wenlock and Ludlow strata.

North of the Silurian tableland and within the area occupied by the Old Red Sandstone, various inliers of Upper Silurian rocks are exposed, which have long been familiar to geologists from the discovery of eurypterids in the strata in Logan Water by the late Dr. Slimon of Lesmahagow. Recently fresh interest has been imparted to the study of these inliers by the remarkable fish-fauna obtained from the Ludlow and Downtonian strata. The Upper Ludlow rocks of the Lesmahagow inlier have yielded phyllocarid crustaceans and eurypterids in excellent preservation, together with the remains of a scorpion, a myriapod, two species of fishes (*Thelodus*), and other organisms.

Next in order there is a group of red and yellow sandstones, conglomerates, shales, and mudstones, forming passage-beds between the underlying Ludlow strata and the overlying Old Red Sandstone, resembling the Downton rocks of Shropshire. The shales and mudstones intercalated in this series have yielded an assemblage of organic remains, in some respects identical with that of the underlying Ludlow rocks, including ostracods, phyllocarid crustaceans, eurypterids, and fishes. The researches of Dr. Traquair have shown the great biological and palaeontological value of this fish-fauna. The discovery of these organic remains in the passage-beds has led to a change in the classification of these rocks by the Geological Survey. Though formerly grouped with the Old Red Sandstone, they are now regarded as forming the highest subdivision of the Silurian system in the south of Scotland. The band of greywacke-conglomerate which is traceable from the Pentland Hills into Ayrshire, save in certain parts of Lanarkshire, is now regarded as the base line of the Lower Old Red Sandstone. For it is not till we reach the horizon of this greywacke-conglomerate that evidence is found of the predominance of materials which have been derived from the Silurian tableland.

In the northwest part of the tableland the Silurian strata are pierced by various plutonic rocks, of which the largest is the granite mass stretching from Loch Doon to Loch Dee. According to Mr. Teall this mass includes various petrological types, as, for example, granitite, hornblende-granitite, quartz-augite-biotite-diorite, and quartz-biotite-hyperite.

Towards the close of Downtonian time the Silurian strata of the south of Scotland were elevated and subjected to prolonged denudation, for we find, both in Ayrshire and in the Pentland Hills, the basal conglomerates of the Lower Old Red Sandstone resting unconformably on the folded and eroded edges of the Silurian rocks. In Lanarkshire, however, there seems to be a passage from the one formation to the other. At that period also, the crystalline schists of the Highlands must have formed a prominent land barrier towards the north before the deposition of the Lower Old Red Sandstone sediments.

The various divisions of the Old Red Sandstone as developed in the Clyde territory are represented in the following table:

OLD RED SANDSTONE.	Upper.	Band of cornstone near the top. Red sandstones and conglomerates.
	Unconformability.	
	Lower.	3. Sandstones, grits, and conglomerates with pebbles of andesite. 2. Contemporaneous volcanic rocks (andesites and tuffs) with thin intercalations of sandstones and conglomerates near the top. 1. Chocolate-coloured sandstones with *Cephalaspis Lyelli* and conglomeratic bands, with greywacke-conglomerate at the base.

Lower Division. On the south side of the great midland valley, and along the margin of the Silurian tableland there is an important development of the lower division of the Old Red Sandstone. On the south side of the Girvan valley, the members of group 1 rest unconformably on an eroded platform of Silurian rocks, and on the north side of the same valley they reappear, and are largely developed near Maybole and Kirkoswald, passing northwards underneath the overlying volcanic series (group 2 in table) which extends north by Dunure Castle to near the Heads of Ayr. In Lanarkshire the Lower Old Red Sandstone is let down against the Silurian strata by the great fault which skirts the tableland. The red sandstones and conglomerates (group 1 in the table) are well seen in the gorge of the River Clyde at Lanark, whence they stretch westwards by Lesmahagow to near Darvel in Ayrshire, where they pass underneath the overlying volcanic series (group 2). The volcanic group is also exposed on the slopes of Tinto, and can be traced westwards to near Douglas, reappearing in the Duneaton Water to the west of the Douglas coalfield. Along their southeast margin the lavas and tuffs pass upwards into the members of the overlying beds (group 3). Indeed between the Duneaton Water and the Clyde at Lamington the beds forming the highest division of the Lower Old Red Sandstone lie in a synclinal fold of the volcanic series (group 2). Grits and yellow sandstones occurring at the base pass upwards into massive conglomerates, and these are overlaid in turn by chocolate-coloured sandstones. These beds furnish evidence of the cessation of volcanic activity, for the sandstones are largely composed of volcanic detritus, and the pebbles in the massive conglomerates consist mainly of andesite.

The Lower Old Red Sandstone strata in Lanarkshire and Ayrshire are traversed by various basic and acid eruptive rocks. Near the head-waters of the Avon, southeast of Darvel in Ayrshire, a small mass of granite occurs, containing petrological types, which, according to Dr. Flett, resemble those met with in the Loch Doon granite, both masses being presumably of the same age. Numerous sills of acid material have been injected, mainly along the lines of bedding of the lower red sandstones, of which the massive sheet of quartz-felsite on the crest of Tinto are a conspicuous example.

On the north side of the midland valley the members of the Lower Old Red Sandstone can be traced from the Forth above Stirling, west by Drymen, to a point on the Firth of Clyde, near Cardross. In the eastern part of this area the strata are arranged in a great synclinal fold, the central axis of which coincides with a line drawn from Flanders Moss, in the valley of the Forth, to near Drymen. The strata forming this syncline belong to the highest division of the Lower Old Red Sandstone (group 3), for on the southeast side the volcanic series (group 2) rises from underneath these sandstones in the Ochil Hills, where the lavas, tuffs, and agglomerates reach their greatest development in Scotland. On the north side of this great syncline a representative of the volcanic series is found near Aberfoyle close to the great Highland fault. Here a band of andesite appears, overlaid by massive conglomerates and sandstones which are highly inclined or vertical. Southwards the angle of inclination decreases, and the strata have a gentle dip on both sides of the synclinal axis, where they consist of grey sandstones, which yielded to Mr. R. L. Jack plant-remains, regarded by Mr. Kidston as specimens of *Arthrostigma* (Dawson).

Representatives of the Lower Old Red Sandstone likewise occur in Arran to the east and south of the granite area. In the latter district Mr. Gunn recently detected the volcanic zone in association with the sandstones. The Lower division is largely developed in the extreme southeast of Kintyre between Campbeltown and Southend, where the sandstones are accompanied by trappean conglomerates and pierced by necks of volcanic agglomerate.

Upper Division. At the close of the Lower Old Red Sandstone period important geographical changes again ensued, for everywhere there is a marked unconformability between the upper division of this system and older formations. The vast accumulation of deposits, both sedimentary and volcanic, of the lower division was elevated, folded, and subjected to prolonged denudation. Indeed, in some instances, the old Silurian tableland was trenched by narrow valleys, as in the far northeast in the Lammermuirs. Subsidence again ensued, but as yet the marine fauna of the Carboniferous period was excluded from the area of sedimentation. Though the Upper Old Red Sandstone rests everywhere unconformably on older formations, it graduates upwards into the Carboniferous rocks. Indeed it was at one time regarded as forming a lower subdivision of the Calciferous Sandstone. Lithologically the red sandstones of the upper division resemble those of the lower, and they likewise yield land-plants and fishes. The fish-fauna, however, is wholly different from that met with in the Caledonian or lower division, one of the most characteristic forms being *Holoptychius nobilissimus.*

In Upper Clydesdale the Upper Old Red Sandstone extends from Hyndford Bridge on the Clyde, east by Carnwath, to Dunsyre Hill, being a continuation of the Cairn Hill sandstones of the Pentland chain. In Ayrshire it is traceable from the shore at the Heads of Ayr, in a southeasterly direction,—lapping round the Lower Old Red volcanic rocks, and underlying red sandstones,—to Blairquhan in the Girvan Valley. There the cornstone near the top of this division is well seen in the Lannielane quarries, south of Kilkerran Castle. Again to the north of the Campsie and Kilpatrick Hills a narrow belt of these red sandstones can be traced from Kippen, by Killearn, to the Firth of Clyde near Cardross. Here there is additional evidence of the marked unconformability between the two divisions of the system, for the upper red sandstones dip to the southeast, and the lower are inclined to the northwest. The cornstone near the top of this series has been traced at intervals along the north side of the Campsie Fells, and has been worked for lime between Balfron and Gargunnock. On the shores of the Firth of Clyde the Upper Old Red Sandstone is traceable from Wemyss Bay, southwards by Largs and Fairlie, to Ardrossan. On the promontory at Rosneath, at Toward Point, and again in the island of Bute, it is faulted against the crystalline schists of the Highlands. These red sandstones likewise occur in Arran, both to the east and south of the main granite mass, and likewise in Kintyre to the southwest of Campbeltown, and on the west coast near Cleongart.

The Carboniferous formation is largely developed in the West of Scotland where it occupies the greater part of the Central Lowlands, extending westwards to the shores of the Clyde, and southwards to Dalmellington in the County of Ayr. There is sufficient evidence for maintaining, however, that originally it must have covered a much wider area, for though the Silurian tableland may have formed a land-barrier during the beginning of the period, yet as it advanced portions of the tableland were submerged and buried underneath these deposits.

The various divisions of the Carboniferous system as developed in the West of Scotland are given in the following table:

The Carboniferous System.	Upper Carboniferous.	Coal-measures.	2. Red sandstones, shales, fireclays, and marls, with no workable coal-seams.
			1. Numerous valuable coal-seams and ironstones, white and grey sandstones, dark shales and fireclays.
		Millstone Grit.	Coarse grits and sandstones, with thick beds of fireclay, and occasional thin coals, ironstones, and thin limestones.
	Lower Carboniferous.	Carboniferous Limestone Series.	3. Upper group of three or more limestones, with sandstones, shales, and thin coals, including the Castlecary, Calmy, and Index limestones in descending order.
			2. Middle group, with several workable coal-seams and ironstones, sandstones and shales, but no limestones.
			1. Lower group, with several beds of limestone, sandstones, shales, coals, and ironstones. At or near the base lies the Hurlet limestone.
		Calciferous Sandstone Series.	Blue, grey, green, and red clays, marls, shales, and sandstones, with cement-stone bands. (Ballagan series.)

Reference has already been made to the gradual passage from the Upper Old Red Sandstone deposits to the Cement-stone group at the base of the Carboniferous system in the West of Scotland. But evidence will be adduced to show that in certain areas there is a strong overlap of the succeeding deposits, for the Calciferous Sandstones, Carboniferous Limestones, and even the Coal-measures, each in turn rest directly on older rocks.

The Cement-stone group in the West of Scotland presents uniform lithological characters; the beds consisting of variegated clays, marls, shales, and sandstones, with cement-stone bands which are well exposed in Ballagan Glen near Strathblane. They are comparatively unfossiliferous, but they yield occasionally plant-remains, entomostraca, and fish-scales. Along the north and west sides of the Campsie Fells they are overlaid by white sandstones, and fine tuffs which herald the great outburst of volcanic activity during the Calciferous Sandstone period in Scotland. Indeed this development of volcanic energy rivals in importance the volcanic phase of the Lower division of the Old Red Sandstone. Sir A. Geikie in his recent work on "The Ancient Volcanoes of Britain" has depicted the extent of these plateau-eruptions and described the various petrological types which they include. The lavas comprise olivine-basalts, andesites, and trachytes, which are associated with pyroclastic materials. A noteworthy feature is the number of necks or vents—now filled with agglomerates or massive igneous rocks—from which the volcanic materials may have been discharged, as for example near Strathblane, Fintry, and in Renfrewshire. In the Clyde territory these plateau-eruptions give rise to striking features in the landscape. They form the Campsie Fells, where the terraced appearance of the lava-flows is well displayed, and stretch westwards by the Kilpatrick Hills to the Clyde at Bowling. On the south side of the estuary, they are traceable from Bishopton to the hills behind Gourock, thence they extend southeastwards for a distance of thirty miles to Strathavon, where they form a gentle anticlinal fold between the Carboniferous basins of Lanarkshire and Ayrshire. On the east side of the Firth of Clyde they stretch from Gourock by Largs to Ardrossan, they appear in Bute and the Cumbraes, they underlie the Hurlet limestone at Corrie in Arran, and they are well developed to the southwest of Campbeltown, where they rest directly on the sandstones and cornstones of the Upper Old Red Sandstone. Sir A. Geikie has called attention to the thickening and thinning of the lavas in different directions, which has been proved by the detailed mapping of the Geological Survey. For while the plateau-eruptions reach a thickness of 3000 feet in the Kilpatrick Hills they gradually thin away eastwards and disappear east of Stirling.

Though in the neighbourhood of the Campsie and Kilpatrick Hills, and again between Greenock and Ardrossan, the Lower Carboniferous volcanic rocks rest on the Cement-stone series, yet where the volcanoes remained active for a long course of time this subdivision is sparingly developed. Occasionally there are intercalations of sedimentry material, as, for instance, near Eaglesham, where Professor James Geikie mapped sandstones, shales, clay-ironstones, and impure limestones with *Productus giganteus*, which are intercalated in tuffs. Plant-remains are frequently entombed in the tuffs, as, for instance, on the east coast of Arran—a locality discovered by the late Mr. Wünsch—and they sometimes form thin seams of coal in the volcanic series, as near Bowling, described by the late Dr. John Young.

Near the top of the volcanic series there is a gradual passage through fine tuffs, which contain much sedimentary material, into the basement beds of the Carboniferous Limestone series. This passage has been traced round the north portion of the Ayrshire field near Kilbirnie, and from Beith to Stewarton; again near Eaglesham in Renfrewshire, and at the foot of the Campsie Fells, west of Kilsyth. It is thus obvious that the Lower Carboniferous volcanoes, in certain portions of the Clyde area, must have remained active during the greater part of the Calciferous Sandstone period. Such prolonged volcanic activity accounts in great measure for the absence in the West of Scotland of the upper or oil-shale group of the Calciferous Sandstone series met with in the basin of the Forth. The latter possesses different lithological characters from those of the Cement-stone group, for they consist of oil-shales, blue and black shales, clay-ironstones, estuarine and marine limestones, yellow sandstones, and occasional seams of coal. Recently fine sections of the Cement-stone group have been exposed in artificial openings in the old part of Edinburgh, where they pass underneath the volcanic rocks of Arthur's Seat—the equivalents of the Renfrewshire volcanic series—these in turn being overlaid by the oil-shale group of the Lothians. The members of the latter group, so well developed in Midlothian and Linlithgowshire, are traceable southwestwards as far as Auchengray near the east boundary of Lanarkshire, but their occurrence has not been proved to the west of that locality.

The triple classification of the Carboniferous Limestones series (see Table, p. 407) is well represented in the Clyde territory. This division forms a belt of variable width surrounding the great Lanarkshire coal-field on the north, west, and south sides. Frequently the strata are faulted against the underlying volcanic series, as along the southern slope of the Campsie Fells. The Hurlet limestone is the lowest limestone of the series, and is one of the most persistent bands. In the Carluke district the lowest group contains from twelve to fifteen beds of limestone, but the two best known seams in it are the Hurlet and the Hosie limestones. The middle group contains several workable coal-seams, of which the Lesmahagow gas-coal is one of the important seams, and in the lower portion of this group there are valuable bands of ironstone. The upper group comprises three beds of limestone, the lowest being the Index—so named because it overlies the valuable coal-bearing subdivision of the Carboniferous Limestone, the middle being the Calmy, and the upper the Gair or Castlecary band. The same subdivisions are represented in the Ayrshire field, with this important modification, that the lowest or Hurlet limestone has an exceptional development near Beith, where it is about 100 feet thick, and is richly charged with marine organisms. In the northern parts of the same basin, at Dalry, evidence has been obtained of the existence of buried volcanoes, filled with tuff, which Sir A. Geikie assigns to the period of puy-eruptions that followed the volcanic phase of the Calciferous Sandstone period. He states that in one pit upwards of 115 fathoms of tuff were passed through before the position of the blackband ironstone in that portion of the field was reached by driving levels through the tuff into the adjoining strata. The tuff occurs in patches between which the blackband ironstone is workable. It is evident that volcanic cones must there have been locally developed during the deposition of the ironstone, and that these were eventually buried by higher deposits of the Carboniferous Limestone series.

The Carboniferous Limestone series with the group of workable coals, occurs in various small isolated basins, as, for instance, in the Douglas field in South Lanarkshire, at Dailly in Ayrshire, and to the west of Campbeltown in Kintyre. Representatives of this series, with its three subdivisions, are met with on the east coast of Arran between Brodick and the Cock of Arran, but the coal-seams there appear in an attenuated form and are not now worked.

The series of deposits just described points to a succession of marine conditions, to the existence of shallow lagoons and mud-flats, and of land-surfaces. It is evident that during the Carboniferous Limestone period the land was steadily subsiding with long intervals of repose, and this irregular subsidence of the land produced overlaps of the strata. For example, the Upper Old Red Sandstone of the Pentland Hills, when traced westwards, is overlapped by the Calciferous Sandstone, and still further west, near Lesmahagow, the Cement-stone group is in turn overlapped by the Carboniferous Limestone series, which there rests unconformably on the Lower Old Red Sandstone along the south margin of the Lanarkshire field. Similar evidence is obtained in the south part of the Douglas basin, where the Carboniferous Limestone transgresses the Cement-stone group, and reposes on the Lower Old Red Sandstone. Further proof of the southward extension of the Carboniferous rocks and of overlap is found south of Tinto Hill in Lanarkshire, where, in a small outlier, the Calciferous Sandstone disappears, and the Hurlet limestone rests directly on the Lower Old Red Sandstone. Again, between Dalmellington and New Cumnock conglomerates are associated with the Carboniferous Limestone in such a way as to point to an overlap of that series on to the Old Red Sandstone.

Throughout the Lanarkshire field the Carboniferous Limestone is overlaid by the Millstone Grit series, which consists of massive, white, yellow or red sandstones associated with thin coal-seams, thin limestones, ironstones, and valuable fireclays. In the south part of the basin, where it is of considerable thickness, it occurs to the northeast of Carluke and north of Auchenheath, while in the north part of the basin the fireclays are worked at Glenboig, Gartcosh, and Garnkirk. In the Ayrshire basin the Millstone Grit is absent, at least in some parts of the field, for the Coal-measures rest directly on the Carboniferous Limestone series. On this horizon, however, an interesting band of volcanic rocks has been traced round the east and north sides of the Coal-measures, which, according to Sir A. Geikie, seems to mark the latest Carboniferous volcanoes. Where most fully developed, these rocks consist of bedded basalts and tuffs, reaching a thickness of 600 feet. In the Geological Survey map (sheet 14) they form a conspicuous feature, intervening between the Carboniferous Limestone and the Coal-measures along the east side of the field near Kilmaurs, but they thin away and appear as a narrow band between Kilwinning and the shore section at Saltcoats. It is interesting to note that a band of fine tuff, occupying the same horizon at the base of the Coal-measures, has recently been detected by Mr. Gunn in Arran, and a similar band has been found in the strip of Carboniferous rocks on the west side of Loch Ryan. No contemporaneous volcanic rocks occur on this horizon in the Lanarkshire basin.

Though the massive sandstones of the Millstone Grit imply the accumulation of coarse sediment near the land, still the shales, ironstones, and impure limestones in this division have yielded plants, brachiopods, crustaceans, fishes and other organisms, pointing to the existence of marine conditions.

The Coal-measures overlying the Millstone Grit are divisible into two groups, a lower, containing numerous valuable coal-seams, ironstones, fireclays, bituminous shales, sandy shales, and sandstones, and an upper group of red sandstones, fireclays, marls, and thin coal-seams, resting, probably with a slight unconformability, on the lower. The vertical section of the Clyde coal-field, published by the Geological Survey, shows eleven coal-seams and seven seams of ironstone in the lower group, in the central portion of the basin. ("Explanation" of sheet 23, one-inch Geological Survey Map, page 36.) Some of the seams rest on a bed of fireclay, representing the old land-surface, while others have no underclay; the latter may be due to the drifting of vegetable matter. The red sandstone group overlying the valuable mineral field in Lanarkshire extends up the valley of the Clyde from Cambuslang by Bothwell to Hamilton, being admirably seen in the quarries near Uddingston. These two groups are represented in the Ayrshire field. Quite recently Mr. Gunn has detected representatives of the Coal-measures in Arran, in tributary branches of the Sliddery Water, which have yielded two species of *Carbonicola*, and several species of fishes appearing to be characteristic of the Upper Carboniferous formations in Scotland, together with specimens of *Lepidodendron Veltheimianum*, which, according to Mr. Kidston, has never yet been found above the Carboniferous Limestone. The shales, ironstones, and other sediments yielding these fossils are there associated with fine tuffs, coarse volcanic ash, and lavas, to which reference has already been made in connection with the volcanic zone at the base of the Coal-measures in Ayrshire. (Summary of Progress, Geological Survey, 1897, page 113.) From the constant succession of coal-seams, ironstones, sandstones, and shales throughout the Coal-measures it may be inferred that land conditions alternated with slight submergence during the accumulation of these deposits. That the irregular sinking of the Silurian tableland led to overlaps during the Coal-measure period is conclusively proved in the Sanquhar District, and near Loch Ryan. For in the former region both the Calciferous Sandstone and the Carboniferous Limestone are overlapped, and the Coal-measures rest unconformably on Silurian strata in the Sanquhar basin. Again, on the west shore of Loch Ryan the shales occurring in the strip of Carboniferous rocks, which there rest on the Silurian floor, have yielded plants characteristic of the Coal-measures.

Reference must be made to the researches of Mr. Kidston, who, by means of the plants, has pointed out the existence of a great palaeontological break at the base of the Millstone Grit. A similar conclusion has been independently arrived at by Dr. Traquair from an examination of the fishes.

Numerous dykes and sills pierce the Carboniferous strata of the Clyde territory. The dykes, which may be referred to the period of the plateau-eruptions of the Calciferous Sandstone period, consist mainly of trachyte or andesite, and others of diabase, basalt, or dolerite. The intrusive sheets of that epoch likewise consist mainly of andesite or trachyte. Mr. Gunn has observed that in Bute and the Cumbraes the dykes of trachyte, basalt and dolerite sometimes pass into intrusive sheets. A prominent series of sills of a more basic character is largely developed along the northern belt of the Carboniferous Limestone series in the midland valley. These dolerite sills occur at Kilbarchan, Johnstone, and Paisley, and they extend at intervals from Milngavie by Kilsyth to Stirling, where one of these intrusive sheets forms a conspicuous feature in the Castle Rock. These basic sills are linked with the puy-eruptions of Carboniferous Limestone time by Sir A. Geikie.

In the Ayrshire basin of Carboniferous strata there is an oval-shaped area of volcanic and sedimentary rocks which have been referred to the Permian period. They rest on the upper or red sandstone group of the Coal-measures. The margin of this Permian basin consists of sheets of lava and volcanic tuffs, interstratified with brick-red sandstones, and these are overlaid by false-bedded red sandstones. The lavas are well seen in the course of the river Ayr above Ballochmyle, and the red sandstones in the large quarries near Mauchline. Outside the Permian basin, numerous necks or vents, filled with volcanic agglomerate, pierce the Coal-measures which have been referred to this period of volcanic activity. Since the discovery of Rhaetic and Liassic fossils in Arran, which has led to the grouping of the red sandstones in the south of Arran with the Triassic strata, it has been suggested that the Mauchline sandstones may be of the same age.

The part of Arran lying to the south of a line drawn from Brodick to Blackwaterfoot on the west coast is occupied by a great development of false-bedded red sandstones, conglomerates and marls, which are now regarded as of Triassic age. This correlation is based on the discovery of Rhaetic fossils characteristic of the Avicula contorta-zone, and Lower Liassic fossils in masses of shale, marl, limestone, and sandstones, which do not now occur in place on the island. These portions of sedimentary strata are associated with fragmental volcanic materials, and various intrusive igneous rocks which now fill a great volcanic vent. Its site is about halfway between Brodick Bay on the east and Machrie Bay on the west, and to the south of the String Road which crosses the island from Brodick to Shiskine. This discovery was made by Messrs. Peach, Gunn, and Macconochie, in the course of the Geological Survey of that district. The occurrence of these sedimentary masses, one of which is acres in extent, points to the former existence in the Clyde area of Rhaetic and Lower Liassic strata which have now been swept away. The detailed mapping of the island by Mr. Gunn has conclusively proved that the Triassic sandstones rest partly on the Coal-measures, partly on the Carboniferous Limestone series, and partly on the Old Red Sandstone. Hence the apparent conformability is entirely deceptive. A patch of these rocks occurs in the north of the island at the Cock of Arran where the late Mr. James Thomson many years ago discovered pebbles with Carboniferous Limestone fossils in the Triassic conglomerate, though at the time he referred the conglomerate to the horizon of the Millstone Grit.

In addition to the Rhaetic and Liassic strata in the volcanic vent near Shiskine, fragments of limestone and chert were found associated with the agglomerate by the Geological Survey. The limestone has yielded fossils of Cretaceous age, including *Globigerina*, *Textularia*, *Porosphaera globularis*, and *Inoceramus*, thus pointing to the existence of Cretaceous strata in the Clyde area, which have been removed by denudation. It is obvious, therefore, that this vent is of post-Cretaceous age, and may with probability be referred to the age of the necks of Tertiary time in Skye. This discovery likewise furnishes valuable evidence in favour of referring the granite mass in the north of Arran, and most of the intrusive, acid and basic igneous rocks in that island to the Tertiary period.

In connection with this development of Tertiary igneous rocks in the island, allusion must be made to the series of basalt and dolerite dykes so largely developed in the Clyde area. They traverse all the geological formations in the region and some pierce the Arran granite, facts which lend support to the view that they belong to the grand outburst of volcanic activity in Tertiary time in the West Highlands.

The phenomena connected with the glacial period in the Clyde territory are of special interest, owing to the extent and variety of the deposits. There is evidence for maintaining that, during the period of maximum glaciation, this area experienced a conflict between the ice which radiated from the Highlands and from the Southern Uplands. The ice that radiated from the West Highlands moved partly down the Firth of Clyde and partly eastwards towards the Firth of Forth. The striae and the dispersal of the stones in the drift prove that part of the ice-stream from the Highlands invaded the Clyde basin and moved southeastwards to Hamilton, where it was met by the ice that descended from the higher grounds in Upper Clydesdale. These two opposing ice-sheets were deflected eastwards to the German Ocean and westwards across the Renfrewshire Hills towards the Firth of Clyde. The ice from the Highlands also overflowed the low grounds of Ayrshire and coalesced with the stream that moved northwards from the hills of Galloway. No less interesting is the evidence furnished by the glaciation of Kintyre. That peninsula was overridden by ice which moved from the Firth of Clyde in a westerly direction—such deflection being due probably to the influence of the ice that radiated from the north of Ireland.

A remarkable feature of the records of glacial time in the West of Scotland is the great thickness of the superficial accumulations, which in one place in the Clyde basin reaches 357 feet. The numerous natural sections reveal the existence of stratified deposits in association with Boulder-clay, which is confirmed by evidence from bores. The data prove the occurrence of more than one Boulder-clay separated by sands, gravels, and silts. Professor James Geikie and the late Mr. Dugald Bell suggested that some of these interstratified deposits may have been lacustrine—the lake having been formed by the Loch Lomond glacier moving southwards across the Clyde at Bowling towards the Kilbarchan Hills, and the waters escaping by Lochwinnoch and Dalry to the Firth of Clyde. But apart from the evidence supplied by the great depth of the superficial accumulations, there is clear proof that the land must have stood relatively at a higher level in pre-glacial time than it does now. Dr. Croll contended that the thickness of stratified deposits found in the bores near New Kilpatrick in the valley of the Kelvin indicated a pre-glacial channel of that river. If his suggestion be correct, then the buried river-course must have entered the Clyde about 200 feet below the present sea-level. This evidence is confirmed by the buried river-channel that joins the Forth near Grangemouth about 260 feet below the sea. Mr. Cadell of Grange has recently obtained similar evidence in the case of the pre-glacial course of the river Almond, which must have entered the Forth about 100 feet below sea-level.

Underneath a thick mass of Boulder-clay in Ayrshire, both at Woodhill quarry near Kilmaurs, and at Drummuir near Dreghorn, stratified beds occur, that have yielded elephant tusks, autlers of reindeer, arctic ostracods, and foraminifera, together with several species of plants, including *Ranunculus aquatilis and Potamogeton.* Mr. John Smith has traced over a wide tract in Ayrshire and as far inland as the Guelh Water near Cumnock, a thick series of inter-glacial sands and gravels up to a height of 900 feet. These are associated with shelly pebbly clay, which he regards as of marine origin. Again, from samples of Boulder-clay near Glasgow Mr. Joseph Wright obtained a large number of foraminifera which were determined by him. Further on the west coast of Kintyre, at Cleongart, dark silt or clay with marine shells is overlain by 76 feet of Boulder-clay at a level of about 180 feet above the sea. In the basin of the Endrick draining into Loch Lomond, Mr. R. L. Jack mapped shelly Boulder-clay up to a level of 320 feet. He considered that the fragments of marine shells in the Boulder-clay had been derived from a pre-existing inter-glacial deposit, formed when the sea stood about 100 feet above its present level.

Among the most interesting records of glacial time in the West of Scotland are the Arctic shell-beds of the Firth of Clyde. They have been investigated and exhaustively described by Dr. Robertson, Dr. Crosskey, and Mr. James Bennie, whose researches have proved the Arctic character of the fauna found in the marine clays. These deposits belong to the period of the 100-feet beach, though owing to denudation they occur now at lower levels. The younger Raised Beaches at 50-feet and 25-feet levels are well developed in the basin of the Clyde. From the deposits of the 25-feet terrace canoes have been exhumed which point to the existence of neolithic man along the shores of the estuary in post-glacial time.

THE CRYSTALLINE SCHISTS OF THE HIGHLANDS.

BY PETER MACNAIR.

THE area occupied by the metamorphic rocks about to be described may be defined as that lying immediately N. of the great boundary fault which, crossing Scotland from shore to shore, with a N.E. and S.W. trend, divides the Highlands from the Lowlands geographically, and the Crystalline Schists from the Old Red Sandstone geologically. The position of this great line of demarcation has been more or less accurately fixed. It can be traced through Arran and Bute, thence from near Toward Castle to Innellan, and across the eastern point of Rosneath peninsula, and by Helensburgh across Loch Lomond northeastwards by way of Balmaha, Aberfoyle, Callander, and Comrie.

The valley of the Clyde proper after traversing the Silurian rocks of the Southern Uplands and the later palaeozoic rocks of the midland valley eventually abuts against the great wall of crystalline schists forming the frontier Highlands near Helensburgh, where the Gareloch runs northwestwards into them. Further on, Loch Long, Loch Goil, the Holy Loch, Loch Striven, Loch Fyne, and other sea-lochs trench deeply into the crystalline schists, exposing along their shores numerous sections of great value in unravelling the structure of this region.

Above Helensburgh the Clyde receives at Dumbarton the waters of Loch Lomond, which drains part of the Highland area, and is the most easterly drainage system falling into the Clyde valley from the crystalline schists of the Highlands. It will, however, be well here to include the ground further east as far as Loch Tay, as the rocks there still occupy their normal positions, whereas along the Firth of Clyde, owing to a succession of earth-movements, the original sequence has been obscured and their physical structure complicated.

As it is impossible to speak with certainty as to the physical structure, succession, or age, of the rocks forming the southern or marginal Highlands, it may be well to briefly sketch the history of opinion concerning them. In 1819 Macculloch[1] pointed out for the first time the opposite directions of the dips in the schists of Cantyre, where the beds of micaceous schist on the eastern shore have an eastern dip, while those on the opposite side dip westwards. Murchison[2] also at a later period refers to an anticlinal fold at Loch Eck. In 1860 Jamieson[3] described in more detail the anticlinal axis observed by Macculloch and Murchison, correlating the argillaceous series of Bute with that of Loch Fyne, which he states arches over into an anticlinal axis, the more arenaceous rocks of Cowal forming the core of the anticline at

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[1] "Western Islands of Scotland," Macculloch, 1819, vol. ii., p. 288.

[2] *Quart. Journ. Geol. Soc.*, vol. vii., p. 169.

[3] "The Geological Structure of the Southwest Highlands," *Quart. Journ. Geol. Soc.*, 1860, vol. xvii., p. 133.

Ben Capuill near Tighnabruaich. This he believed to be a true anticline of the bedding. The altered basic rocks he calls greenstones and points out their intrusive origin.

In 1861 Murchison and Geikie[1] described certain sections along the margin of the southern Grampians with reference to the supposed succession of the rocks in northwest Sutherlandshire. They believed that the southern and central Highlands were overlaid by a great series of quartzites, limestones, and schists, the representatives of those in the northwest, and that they always bore the same relative position to one another, namely the quartzites at the base, followed by limestones, and the whole overlaid by the schists supposed to be of Silurian age. In another paper about the same date these authors maintained, in opposition to the views advanced by Sharpe, that the foliation of the Highland rocks generally coincided with or followed the original planes of sedimentary deposition. In the same year similar views to these were advanced by Harkness[2] as to the rocks south of the Caledonian Canal.

In 1863 the next contribution to the study of these rocks appeared from the pen of James Nicol,[3] and was, in many respects, as I have elsewhere pointed out, the most far-seeing paper which has ever been written on the subject. He entirely discarded the hypothetical views of Murchison, Geikie, and Harkness. Taking a series of sections across the Highland frontier he noted the occurrence in them all of a regular order of clay-slates, grits, greywackes, and quartzites. He also remarked the reversal of dip from S.E. to N.W. as he proceeded from west to east across the Highland frontier, and arrived at the conclusion that the slates along the Firth of Clyde were in their normal position overlying the schists of the interior, whereas these further east as in Perthshire, with a N.E. dip and thus apparently underlying the schists of the interior, did not really do so, their position being really due to a reversal of the beds. This reading is, however, apparently incorrect, the Perthshire slates being really in their normal position, while they are reversed along the Firth of Clyde. Nicol also pointed out the existence of a highly contorted belt on both sides of Loch Long, and strenuously maintained that the central Highland quartzites belonged to a horizon higher than the schists further south, and did not underlie them as had been maintained by Murchison and Geikie.

In 1891, in a Presidential Address to the Geological Society, Sir A. Geikie[4] gave a table of the Highland rocks, the work of the Geological Survey, and placed the Central Highland quartzite at the top, and the phyllites and greywackes of the Pass of Leny at the base of the series. Independently a similar succession was advocated the same year by Henry Coates and the author of this paper. In 1896 the author[5] arranged the clastic rocks of the Highlands in descending order as follows:—Upper Arenaceous zone, Upper Argillaceous zone, Middle Arenaceous zone, Loch Tay Limestone zone, Lower Arenaceous zone, and Lower Argillaceous zone. The principal lithological features and geographical position of each zone was first given, then a series of sections illustrative of their succession and physical structure in Highland Perthshire, and it was pointed out that along the shores of the Firth of Clyde the zones forming the frontier Highlands have been bent into a deep synclinal fold with a reversal of dip.

In 1897, in a Memoir upon the Geology of Cowal,[6] published by the Geological Survey, a series of schist-zones, beginning at the great boundary fault and traversing that region in a northeast and southwest direction, are described. The existence of the anticline first noticed by Macculloch and Murchison and then in detail by Jamieson, as an anticline of the bedding, is recognised, with this important difference, that it is looked upon as a great arch of foliation, and not of bedding as maintained by the earlier geologists. From a comparison of the different schist-zones on each side of the anticline of foliation the conclusion is arrived at that it cannot be also an anticline of the bedding, but that probably it is an original syncline of bedding traversed by an anticline of foliation; a reversion to the view originally maintained by Sharpe—that the folds of the foliation in the Scottish Highlands were entirely independent of the bedding.

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[1] "The Altered Rocks of the Western Islands of Scotland and the Northwestern and Central Highlands," *Quart. Journ. Geol. Soc.*, 1861, vol. xvii., p. 171.

[2] *Quart. Journ. Geol. Soc.*, 1861, vol. xvii., p. 256.

[3] *Ibid.*, 1863, vol. xix., p. 180.

[4] *Ibid.*, 1891, vol. xlvii., p. 74.

[5] *Geological Magazine*, 1896, vol. iii., p. 167 and p. 211.

[6] "Geology of Cowal," *Mem. Geol. Survey*, 1897.

In 1897 the writer[1] further developed the views he had already published in the *Geological Magazine*. The Argillaceous zone along the Highland frontier is the oldest of the schist-zones, and is in its normal position in Perthshire. Westwards, however, towards the Clyde its position becomes steeper and steeper, till in the area of the Firth it becomes reversed, having been pushed backwards and inwards upon the main mass of the Central Highlands. In a series of papers lately contributed to the Geological Society of Glasgow,[2] the writer has again more fully expressed his views regarding the structure and succession of the schists of the Southern Highlands as summarized in the following pages.

It has long been recognised that the metamorphic rocks of the Highlands traverse that area in bands or zones having a general N.E. and S.W. trend roughly parallel with the great boundary fault. The Lower Argillaceous zone abuts against the younger Old Red Sandstone rocks to the south, but separated from it by the boundary fault. Outcropping at the base of the schist-series of the southern Highlands it stretches across the frontier Highlands from sea to sea. In Perthshire it may be seen at Birnam, Logiealmond, Comrie, Callander, and Aberfoyle; in Dumbartonshire at Luss, Row, and Cove; and in Argyllshire at Kirn and Dunoon, crossing the Toward peninsula to Loch Striven, whence it can be traced through Bute from Kames Bay to Ettrick Bay.

The principal rocks of this zone are variously coloured phyllites, including black, blue, purple, grey, green, and buff, with intercalated bands of grit, greywacke, and thin limestones, and they frequently show a finely banded structure referable to their original bedding. Differences of texture may also be observed, more or less gritty bands being often inter-laminated with bands of extremely fine material. Some of these grit bands attain a considerable thickness, such as the Leny and Aberfoyle grits, and the Bull Rock greywacke. Towards the east, as at Birnam, Logiealmond, Comrie, and Callander, this zone of argillaceous rocks is not so highly metamorphosed as on the Firth of Clyde, having more the appearance of a clay-slate. In many instances, as in the quarries at Logiealmond, Aberuchill, and the foot of Loch Lubnaig, the bedding is distinctly folded, the folds being crossed by planes of cleavage. Rarely, however, can any folding or crumpling in the cleavage-planes themselves be detected so that the rocks might here be more fitly called clay-slates than phyllites. Towards the Firth of Clyde there is an increasing development of mica along the cleavage-planes, and at Dunoon there is evidence of more intense metamorphism, secondary foliation-planes being developed, while the cleavage is often violently twisted or folded and the folds crossed by *ausweichung* or strain-slip.

One of the most interesting features in the Lower Argillaceous zone is the evidence it affords of the behaviour of these beds during the process of plication and crushing. An examination of the arenaceous beds with which these phyllites have been interstratified, and of the Arenaceous zone which succeeds them to the north, generally reveals the planes of foliation and shear to be roughly coincident with the bedding, though there are numerous exceptions. In many places, such as in the Dunoon section, the foliation-planes in the phyllites have been themselves folded, and that oftener than once. This structure is only explicable on the supposition that the argillaceous beds must have been driven *en masse* between the more massive arenaceous beds with which they were interstratified, the latter having simply a rough foliation developed along their original bedding-planes, while the argillaceous beds were twisted into innumerable folds with a much more perfect foliation.

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[1] *Trans. Perth. Soc. Nat. Science*, vol. ii., 1897, p. 166.

[2] *Trans. Geol. Soc. of Glasgow*, vol. xi., part 2, 1900, p. 273.

Immediately N.W. of this Lower Argillaceous zone another broad band of rocks, with a more or less developed foliation occurs. Because of the predominance in it of coarsely fragmental materials it is here termed the Lower Arenaceous zone, varying from exceedingly fine-grained light and dark greywackes to massive grits with pebbles often an inch in diameter. These pebbles generally consist of quartz or felspar set in a finely comminuted felspathic matrix.

Associated with these rocks occurs a group known as "the green beds" because of their marked greenish colour. They generally show a more or less well-developed schistose structure and are characterised by the presence of granular epidote, chlorite, and dark green or brown biotite. That they are of fragmental origin seems undoubted, but the conditions under which they were originally deposited are uncertain. When first mapped by the officers of the Survey they were supposed to be of pyroclastic origin, the green colouring matter being looked upon as similar to the fine dust of volcanic tuff, but the complete absence of interbedded lava-flows, or of any pebbles referable to igneous rock, throws doubt upon such an origin. Like the phyllites they immediately succeed they exhibit a gradually increasing metamorphism from east to west, the grits and greywackes becoming more highly schistose.

Geographically this Lower Arenaceous zone may be traced from St. Fillans, in Perthshire, through Ben Vorlich, Ben Ledi, and Ben Venue, giving rise to the characteristic scenery of the Trossachs; thence along the shores of Loch Lomond below Rowardennan and Inverbeg into Cowal, where it may be seen at the head of the Gareloch, and along Loch Eck, where it gives rise to a peculiarly rugged type of scenery.

Above the group just described occurs one of the best marked zones of all the schists seen in the southern Highlands, that known as the Loch Tay limestone, the typical rock of which is a crystalline, black, grey, or mottled limestone, generally showing distinct crystals of calcite. With it are associated beds of calcareous mica-schist which often appear to split the limestone up into several bands. It is well exposed along the shores of Loch Tay, and can be traced westwards along Glen Dochart to near Crianlarich, and thence into Argyllshire at Ballimore, near Strachur, in Glendaruel, and near Kilfinan. Upon this horizon occur massive beds of sheared basic rocks which accompany the limestone in a remarkable manner from E. to W. across the whole of the southern Highlands.

Above this zone comes a band of mica-schists and quartz-schists characterised by the abundance of their garnets, sometimes in such quantities as to form the larger bulk of the rock. This group which has been named the garnetiferous schist-zone, forms a tolerably well-marked horizon immediately above the Loch Tay limestone, and can be traced along the mountains N. of Loch Tay into Glen Dochart, and thence into Argyllshire, where it accompanies the limestone which it apparently overlies.

A well-marked group of phyllites, schistose-quartzites, and graphite-schists, the Upper Argillaceous zone succeed this. Like those of the Lower Argillaceous zone, the rocks of this zone seem to have been driven between the more massive beds, and to have suffered intense metamorphism, the foliation-planes having been folded and twisted to an almost inconceivable extent. This is well seen in the mountains N. of Loch Tay and along Loch Fyne. Geographically this zone may be traced through the summits of Ben Lawers, Craig Na Calliach, and on to the high ground separating Glen Lochy and Glen Dochart. At Tyndrum it is faulted against the central Highland quartzites, whence it runs N.E. towards Loch Lyon, and it is also well exposed along both the E. and W. shores of Loch Fyne.

Succeeding the Upper Argillaceous zone and covering a great part of the central Highlands there is a group of quartzites and limestones here named the Upper Arenaceous zone, because of the predominance in it of the quartzites. It can be seen in the neighbourhood of Blair Atholl, the limestones being well exposed in Glen Tilt, whence they can be traced westwards through Schiehallion, Glen Lyon, the Black Mount, and Dalmally, to the shores of Loch Awe.

Associated with these different zones are other schists which have originally been intruded into the sedimentary schists as sills of igneous rock, prior to the general metamorphism of the region. These have suffered along with the clastic rocks, and are now known as epidiorites and hornblende schists. A remarkable development of them is to be found along the horizon of the Loch Tay limestone, and in the schists immediately above and below it. Though they now in many instances present a perfectly developed schistose structure, they have originally been igneous rocks of a basic character. Serpentines and chlorite-schists, both, probably, of igneous origin, occur here and there throughout the area.

The following table gives the principal schist-zones, with their characteristic rocks. For reasons to be afterwards shown it is probable that the order given in the table is a descending one, the newest rocks being placed at the top, the oldest at the bottom:

TABLE OF THE METAMORPHIC ROCKS OF THE SOUTHERN HIGHLANDS.

Schists of Sedimentary Origin.	VI. Upper Arenaceous zone	Dark Schist. Limestone. Boulder Bed. Quartzite.
	V. Upper Argillaceous zone	Graphite-schist. Phyllites. Schistose-quartzite. Calcareous Serecite-schists.
	IV. Garnetiferous schist zone	Garnetiferous Mica-schist. Quartz-schists. Mica-schists.
	III. Loch Tay Limestone zone	Limestones. Calcareous Mica-schists.
	II. Lower Arenaceous zone	Green Beds. Mica-schists. Grits and Conglomerates. Greywackes.
	I. Lower Argillaceous zone	Slates. Phyllites. Grits. Greywackes. Thin Limestones.
Schists of Igneous Origin.	Hornblende-schists. Epidiorites. Serpentine. Chlorite-schist.	

The two sections (page 420) will perhaps show more clearly the comparative physical structure of the area—the one in Perthshire typical of the structure of the eastern, and the other in Cowal of the western part. The eastern section runs from Comrie to Ben Lawers, and in the neighbourhood of Comrie the foliation-planes of the clay-slates, the representative rocks of the Lower Argillaceous zone, dip at high angles towards the northwest. These rocks are also well exposed on the eastern shore of Loch Lubnaig. Further west where the foliation has the same dip, the bedding-planes have at places undergone considerable folding, but generally dip in the same direction as the foliation. Above this zone, and succeeding it to the N.W., comes the Lower Arenaceous zone with its characteristic beds of grit and greywacke, which are all well exposed in the gorge of the Lednock N. of Comrie, and strike to the S.W. across the summits of Ben Vorlich and Ben Ledi. Tracing the section to the N. it will be found that these rocks continue up Glen Lednock with a gradually decreasing dip from the high angles along the Highland frontier, till near the watershed they become almost flat. On the summit of Meal Na Creige, a mountain overlooking Loch Tay, we find an outlier of the Loch Tay limestone zone, consisting of calcareous mica-schist with accompanying sills of epidiorite. To the W. of this the powerful Glen Ample fault truncates the schist, throwing down the Loch Tay limestone, and ushering in the shallow trough of limestones and schists stretching from Glen Beich westward across the Braes of Balquhidder towards the shores of Loch Katrine.

Descending Meal Na Creig to the other side of Loch Tay we find the Loch Tay limestone and its associated basic rocks dipping N.W. below Ben Lawers. Ascending the sides of the Ben these are succeeded by the garnetiferous schist-zone, and at about 2500 feet are in turn overlaid by the highly contorted phyllites, schistose quartzites, and black graphitic schists of the Upper Argillaceous zone. Down the northern side of the mountain towards Glen Lyon, the Loch Tay limestone with its associated epidiorites again rises to the surface, thus showing that the mountain has been carved out of a syncline of schists. At this point the quartzites of the Upper Argillaceous zone are seen to be cut off by a fault, but elsewhere the passage of the graphite-schists into the quartzite is clearly seen.

In the western portion of the area the section is taken across Cowal, from Dunoon to Inverary. At Dunoon on the Firth of Clyde the lower argillaceous zone is exposed along the shore from Hunter's Quay to Innellan, where the dip of the principal foliation is southeast at an angle of 53°. In many places, as already observed, the bedding shows evidence of being much folded. Up the Holy Loch towards the north, the phyllites are succeeded by a group of green beds, mica-schists, schistose-grits, and greywackes, the representatives of the Lower Arenaceous zone, dipping southeast at about 53°.

From the head of the Holy Loch they begin to undulate, till at the foot of Loch Eck they give evidence of having been subjected to most violent twisting and contorting. This belt of highly contorted schists extends northwards towards the head of Loch Eck, when again the twisting diminishes and the dip is reversed, being now northwest at much gentler angles. At Ballimore the Loch Tay limestone, with its associated hornblende-schists, is exposed, dipping also northwest, and above it comes the garnetiferous schist-zone, seen in several of the stream-sections. On the shores of Loch Fyne the Upper Argillaceous zone is met with, with its characteristic phyllites and quartz-schists which cross to the north side of the loch and are well exposed near Inveraray. In Glen Aray these rocks are succeeded by the more massive quartzite beds, and limestones, so well developed along the shores of Loch Awe, which belong to the Upper Arenaceous zone, and below which the Loch Fyne phyllites pass in a shallow syncline or trough.

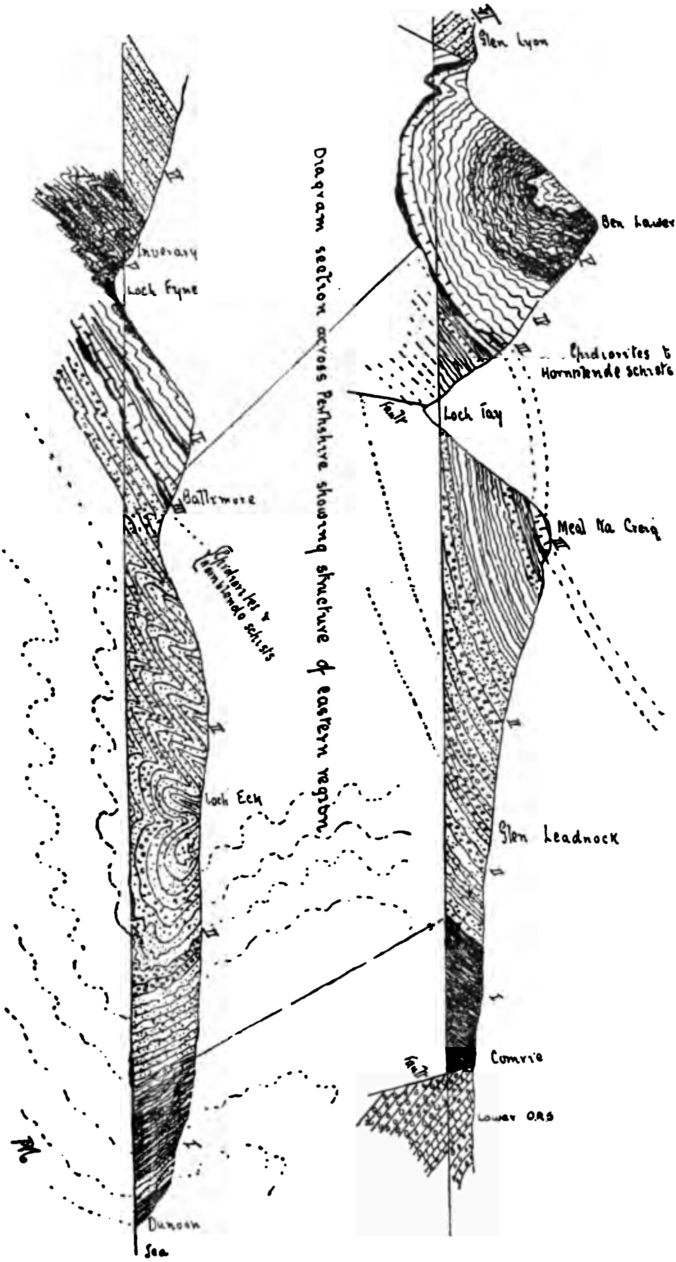

Diagram section across Cowal showing structure of western region.

Diagram section across Perthshire showing structure of eastern region.

NOTE.—In the above sections of the Crystalline schists the lines represent foliation-planes, not necessarily bedding-planes.

From a consideration of these two sections it would seem that in the eastern one across Perthshire we have the nearest approach to the normal order of the rocks. In the interior of Highland Perthshire they are comparatively flat, but as the Highland frontier is reached the dip rapidly increases to high angles, still, however, dipping beneath the rocks of the interior. Here there is a syncline, of which the northern limb is comparatively flat and composed of younger rocks, while the southern limb is exceedingly steep ushering in the lower and older beds. This simplicity may, however, be more apparent than real. One is at times inclined to suspect that the bedding has been folded into a series of isoclines, and that the foliation-planes crossing these parallel to the axes of the folds have made the structure appear more simple than it really is, and the thickness of the beds greater than they ought to be.

On the western side of the great fault which passes through Glen Beich the Loch Tay limestone zone seen on the summit of Meal Na Creige has been carried downwards by it, and the structure of the shallow syncline becomes more apparent, being well seen in Glen Ogle and the Kirkton Glen, where the limestones and epidiorites are exposed near the bottoms of the valleys and the overlying schists are seen on the higher grounds. This trough stretches towards the shores of Loch Katrine and the head of Loch Lomond, but in that direction the folding of the beds becomes more intense and the southern limb steeper, until it becomes inverted and pushed over towards the interior. The older rocks coming from beneath the syncline and seen along the frontier Highlands are also placed at high angles, and towards the shores of Loch Lomond they become *reversed*, dipping, also at high angles, to the southeast.

Traced into Cowal and along the shores of the Firth of Clyde the syncline becomes more and more acute, being now actually in a recumbent position with its axis heading towards the southeast at a low angle. The southern limb, consisting of the two lower zones, becomes flatter, the beds dipping southeast at 53°. The rocks, which formed a gentle trough in Perthshire with slightly undulating folds, become more violently contorted. But still their relationship to the eastern section seems to be quite clear, and the supposed anticline of the bedding described by the earlier geologists, and that of the foliation by the officers of the Survey, appear to be entirely deceptive.

Perhaps it may be somewhat misleading to use the term syncline as descriptive of the structure of this region. Strictly speaking it appears to be rather a series of isoclinal folds which traced from Loch Fyne across Cowal to the Firth of Clyde gradually usher in still lower beds. This structure will be better understood by a reference to the sectional diagrams (page 420).

Space does not permit of a detailed description of the minute structure of these schists. An early, and probably the first, foliation of this region took place along the lines of bedding, or parallel to the axes of the folds in the bedding, as is still well seen in the more arenaceous rocks. That this early foliation has been subjected to a series of later movements admits of no doubt, especially in the highly contorted belt which runs through Cowal, the structure of which has been minutely and carefully described by the officers of the Survey. In Cowal there is evidence that an early foliation has itself been folded and crossed by strain-slip, which has again been folded and crossed by still later movements, the process having been repeated oftener than once until all trace of the bedding or early foliation has become entirely obliterated. In the garnetiferous schist-zone and Upper Argillaceous zone of the central Highlands the original clastic rocks seem to have become so completely mineralized that it is almost hopeless to search for evidence of the original bedding, all their divisional planes being clearly of secondary origin, so that it must remain an open question as to the extent to which these secondary planes may be relied upon in determining the original succession of the rocks. Notwithstanding this, and the fact that the foliation-planes are themselves often so intensely folded as to make it difficult to determine even the apparent succession of these secondary planes, yet the relative positions of the principal zones given in this paper seem to be fairly well made out.

Where the foliation-planes have themselves been folded it is interesting to note that the axes of the folds generally head N.W., the overfolding facing S.E., the upper limbs being generally the longer limbs, and the under ones those which are most thinned. As regards the age of these rocks it seems impossible at present to give any definite answer. That they are older than the Lower Old Red Sandstone is evident, from the fact that pebbles of the schists are embedded in the conglomerates of that formation along the Highland frontier.

Along the Highland frontier and immediately N. of the great line of fault the officers of the Survey have discovered a narrow belt of carbonaceous shales, schists and cherts, the latter containing forms resembling Radiolarian tests, which they consider may be of Arenig age. These appear to have been wedged in between the Highland schists and the Old Red Sandstones, and can be traced at intervals through Perthshire and Dumbartonshire into the Island of Arran.

The views expressed in this paper are here offered only as a tentative solution of a difficult problem, upon which it is as yet impossible to speak with assurance.

THE SILURIAN ROCKS IN THE SOUTH OF SCOTLAND.

By B. N. Peach, F.R.S.; J. Horne, F.R.S.; and

A. Macconochie.

INTRODUCTION.

The broad tableland of the Southern Uplands, stretching from the great midland valley southwards to the Solway Firth and the Cheviot Hills is composed mainly of Silurian strata. Along its northern margin, the Silurian tableland is bounded by a powerful fault which lets down the Old Red Sandstone and Carboniferous rocks of the central lowlands; while on the southeast side, in the region extending from the Merse of Berwickshire to the Solway, the Old Red Sandstone and Carboniferous strata rest unconformably on the upturned and eroded Silurian rocks. The scenery of these pastoral uplands is remarkably uniform save where these older Palaeozoic rocks have been pierced by large granite masses, as for example between Criffel and Bengairn and between Loch Dee and Loch Doon. Over much of the tableland there is little variation in the lithological characters of the strata, as they consist mainly of grits, greywackes, flagstones and shales. There are, however, certain bands of black shales richly charged with graptolites, by means of which Professor Lapworth demonstrated the true order of succession of the strata. Everywhere the rocks have been thrown into innumerable folds—frequently inverted and traversed by normal and reversed faults—the axes of which run from southwest to northeast, that is, parallel to the long axis of the tableland.

Along the southern margin of the tableland there is a strip of Wenlock and Ludlow rocks. In the central part of the chain, there is a belt—upwards of twenty miles in width—composed mainly of Llandovery and Tarannon rocks with inliers of the Moffat series of graptolite shales, and extending from the Mull of Galloway by Moffat to St. Abb's Head. In the northern portion, stretching from the northern slopes of the Lammermuir Hills southwest by the Leadhills to Loch Ryan and Portpatrick there is a great development of Arenig, Llandeilo, and Caradoc rocks. The Girvan region which embraces strata ranging from Arenig to Wenlock time is of special interest owing to the abundance of organic remains found on certain horizons. Beyond the northern limits of the Silurian tableland, and within the area occupied by the members of the Old Red Sandstone and Carboniferous systems in Lanarkshire and Ayrshire, there are various exposures of Upper Silurian rocks, of Wenlock, Ludlow and Downtonian age.

Though the portion of the Silurian tableland which falls to be described here is restricted to that embraced in the Clyde basin and adjoining the Firth of Clyde, the following table has been prepared to show the classification of the Silurian rocks throughout the Southern Uplands:

LOWER SILURIAN.

	Central and Southern Belt.		Northern Belt.	Girvan Area.	
Caradoc, - -	Upper or Barren Mudstone Group.	2. Dicell. anceps zone. 1. D. complanatus zone.	Lowther Shales—Wrae, Glencotho, Winkston, fossiliferous beds.	Ardmillan Series. 5. Drummuck group. 4. Barren flagstone group.	
	Lower or Black Shale Group.	3. Pleur. linearis zone. 2. Dicran. Clingani ,, 1. Clim. Wilsoni ,,	Fossiliferous Conglomerate—Duntercleugh, Wallace's Cast. Black shales, with Hartfell graptolites.	3. Whitehouse group. 2. Ardwell ,, 1. Balcletchie ,,	
Llandeilo, -	Upper or Glenkiln Shales.	2. Clim. peltifer zone. 1. Coen. gracilis ,,	Black shales, with *Coenograptus gracilis*, merging into greywackes and shales.	South of R. Stinchar. 3. Boulder Congl. 2. Tappins group. 1. Mudstones, with *Coenograptus*.	North of R. Stinchar. 4. Benan Congl. 3. Graptolitic mudstones. 2. Stinchar Ls. 1. Kirkland Cong.
	Lower.	Radiolarian cherts.	Radiolarian cherts.	Rad. cherts and volcanic series.	Rad. cherts and volcanic series.
Arenig, - -	Radiolarian cherts and volcanic group.		3. Radiolarian cherts. 2. Shelly mudstones. 1. Volcanic series.	3. Radiolarian cherts. 2. Bennane Head black shales. *Phyllograptus*, *Tetragraptus*. 1. Volcanic series. *Caryocaris*. *Tetragraptus*.	

UPPER SILURIAN.

	Central and Southern Belts.	Northern Belt and Inliers of Lanarkshire.	Girvan Area.
DOWNTONIAN, -		Red sandstones, conglomerates, green mudstones. (Fish-band.)	
LUDLOW, - -	Mudstones with limestone nodules. Kirkcudbright shore.	Sandstones, mudstones, and shales. (Fish-band.) Eurypterids, etc.	
WENLOCK, - -	Greywackes and shales, with graptolites. *Cyrtograptus Murchisoni.*	Greywackes and shales. Base not seen.	Blair and Straiton beds.
TARANNON, -	2. Hawick rocks. *Protovirgularia.* 1. Queensberry grits. *Monograptus turriculatus.*		3. Drumyork flags. 2. Bargany group. *Cyrtograptus Grayi.* 1. Penkill group. *Monograptus exiguus.*
LLANDOVERY, -	Birkhill shales. Upper. { 3. Ras. maximus zone. 2. Mon. spinigerus ,, 1. Ceph. cometa ,, Lower. { 3. Mon. gregarius zone. 2. Dip. vesiculosus ,, 1. Dip. acuminatus ,,		Camregan group. *Rastrites maximus.* Saugh Hill group. *Monograptus spinigerus.* Mulloch Hill group. *Diplograptus acuminatus.*

LEADHILLS DISTRICT.

As a prelude to the description of the Leadhills district, brief reference must be made to the geological structure of the classic region of Moffat which embraces the type-sections described by Professor Lapworth, in proof of the sequence and relations of the graptolite-shales of the central part of the tableland. The Moffat black shale series forms narrow boat-shaped areas, being brought to the surface along sharp anticlinal folds, in the midst of the younger Tarannon rocks. From the preceding table it will be seen that the members of the Moffat series have been grouped in three divisions: Glenkiln, Hartfell, and Birkhill; corresponding to the Upper Llandeilo, Caradoc, and Llandovery rocks of Wales respectively, the whole sequence not exceeding 300 feet in thickness. Where denudation has proceeded far enough to expose strata underlying the Glenkiln shales, these consist of Radiolarian cherts and fine tuffs of Lower Llandeilo and Arenig age. The famous Dobb's Linn section at the head of Moffatdale, clearly shows the divisions and structural relations of the Moffat series. When the Moffat series is traced northwards on successive anticlines, towards the northern margin of the central belt of Tarannon rocks, the subdivisions of the Birkhill shales (Llandovery) disappear and are replaced by coarser sediments. Hence at certain localities it is not easy to trace with precision the northern limit of the Tarannon belt.

In the districts of Abington and Leadhills there is a remarkable development of Arenig, Llandeilo, and Caradoc rocks, of greater thickness than their representatives in the Moffat region. A remarkable feature of these northern districts is the occurrence of Arenig volcanic rocks, comprising lavas, agglomerates, and tuffs exposed in the cores of many anticlinal folds. They are immediately overlain by fine mudstones containing abundant hingeless brachiopods (see list), and these in turn by red, dark, and gray cherts charged with Radiolaria (see list). Next in order come the Glenkiln-Hartfell shales yielding their characteristic graptolites of the Moffat region. This sequence is exposed in various folds in the districts of Abington, Leadhills, and Sanquhar. Part of the Lower Caradoc rocks of the northern districts is represented by greywackes, shales, and fossiliferous conglomerates (Duntercleuch, Wallace's Cast, and Kilbucho, see list), while the Upper Caradoc rocks are represented mainly by the Lowther Shales which, to the east of the Clyde basin, include the fossiliferous limestones and conglomerates of Wrae, Glencotho, and Winkston. This change in the type of sedimentation of the Upper Caradoc rocks is also observable in that of the Lower Hartfell and Glenkiln black shales (Lower Caradoc and Upper Llandeilo) when the latter are traced northwards to the margin of the tableland. These in turn are replaced by coarse sediments and the graptolites of the Glenkiln group occur in thin dark seams, interleaved in greywackes and shales.

FOSSILS FROM ARENIG MUDSTONES, ABINGTON DISTRICT.

Tetragraptus fruticosus, *Hall.*
T. quadribrachiatus, *Hall.*
Annelid jaws (?).
Caryocaris Wrighti, *Salt.*
Acrotreta Nicholsoni, *Dav.*
A. sp.
Acrothele granulata, *Linnr.*
A. sp.
Lingula, sp.
Lingulella lepis, *Salt.*
L. quebecensis, *Bill.*
Lingulella, sp.
Linnarssonia, sp.
Obolella like **O. Sabrinae**, *Callow.*
Linnarssonia (Obolella) sagittalis, *Salt.*
L. sp.
Kutorgina labradorica, ? *Bill.*
K. sp.
Discinoid shells.
INCERTAE SEDIS.
Rods, (Sponge ?)

Radiolaria from Arenig-Llandeilo Cherts, Abington District.

Acanthosphaera antiqua, *Hinde.*
Diploplegma cinctum, *Hinde.*
Dorydictum simplex, *Hinde.*
Doryplegma gracile, *Hinde.*
D. nasutum, *Hinde.*
Dorysphaera laxa, *Hinde.*
D. reticulata, *Hinde.*
Haliomma cornutum, *Hinde.*
H. vetustum, *Hinde.*
Spongoplegma priscum, *Hinde.*
Sphaerozoum patutum, *Hinde.*
Sphaerozoum priscum, *Hinde.*
Staurodorus gracilis, *Hinde.*
Stauroplegma brevispina, *Hinde.*
S. barbatum, *Hinde.*
S. compressum, *Hinde.*
S. diffusum, *Hinde.*
Styptosphaera antiqua, *Hinde.*
Triposphaera armata, *Hinde.*
T. densa, *Hinde.*
T. hastata, *Hinde.*
T. Peachi, *Hinde.*

Fossils from the Lower Caradoc Conglomerates of Duntercleugh, Wallace's Cast, and Kilbucho, Abington District.

Cyclocrinus, sp.
Nidulites favus, *Salt.*
Alveolites, sp.
Favosites asper, *d'Orb.*
F. gothlandicus, *Fougt.*
F. sp.
Heliolites, sp.
Lindströmia subduplicata, *M'Coy.*
L. subduplicata, var. **crenulata**, *M'Coy.*
Lyopora favosa, *M'Coy.*
Monticulipora lens, *M'Coy.*
Palaeocyclus, sp.
Petraia bina, *Lonsd.*
P. elongata, *Phil.*
P. uniserialis, *M'Coy.*
P. zic-zac, *M'Coy.*
Stenopora fibrosa, *Goldf.*
Tetradium, sp.
Crinoid stems.
Serpulites longissimus, *Murch.*
Calymene, sp.
Cheirurus clavifrons, *Dalm.*
Encrinurus punctatus, *Brünn.*
Homalonotus, sp.
Illaenus latus (?) *M'Coy.*
Ogygia, sp.
Phacops alifrons, *Salt.*
P. Brongniarti, *Portl.*
P. caudatus, (?) *Brünn.*
Remopleurides Colbii, *Portl.*
R. laterispinifer, *Portl.*
R. sp. nov.
Trinucleus fimbriatus, *Murch.*
T. sp.
Ceriopora oculata, *Goldf.*
Fenestella, sp.
Ptilodictya dichotoma, *Portl.*
P. sp.
Retepora, sp.
Leptaena scissa, *Dav.*
L. sericea, *Sow.*
L. sericea, var. **rhombica**, *M'Coy.*
L. tenuicincta, *M'Coy.*
L. transversalis, *Wahl.*
Orthis biforata, *Schl.*
O. calligramma, *Dalm.*
O. crispa, *M'Coy.*
O. elegantula, *Dalm.*
O. flabellulum, *Sow.*
O. (Strophomena) kilbuchoensis, *Dav.*
O. polygramma, var. **pentlandica**, *Dav.*
O. testudinaria, *Dalm.*
O. vespertilio, *Sow.*
O. sp.
Rhynchonella borealis, *Schl.*
R. Jacki, *Dav.*
R. Stricklandi, *Sow.*
R. sp.
Strophomena arenacea, *Salt.*
S. corrugatella, *Dav.*
S. deltoidea, var. **rotundata**, *Conr.*
S. deltoidea, var. **expansa**, *Sow.*
S. grandis, *Sow.*
S. rhomboidalis *Wilck.*
S. sp.
Ctenodonta levata, *Hall.*
Cucullella, sp.
Modiolopsis orbicularis, *Sow.*
Bellerophon acutus, *Sow.*
B. dilatatus, *Sow.*
B. trilobatus, *Sow.*
Chelodes (Helminthochiton), sp.
Cyclonema, sp.
Ecculiomphalus, sp.
Euomphalus sculptus, *Sow.*
Holopella, sp.
Loxonema, sp.

Maclurea macromphala, *M'Coy.*
Macrochilina, sp.
Murchisonia angulata, *Sow.*
M. gyrogonia, *M'Coy.*
Pleurotomaria alata, *Wahl.*
Pl. (Raphistoma) elliptica, *His.*
Pl. (R.) lenticularis, *Sow.*
Rhaphistoma sp.
Turbo, sp.
Conularia elongata, *Portl.*
Conularia sp.
Hyolithes, sp.
Pterotheca corrugata, *Salt.*
Cyrtoceras scoticum, *Blake.*
Endoceras, sp.
Lituites, sp.
Orthoceras arcuoliratum, *Hall.*
O. Avelini, *Salt.*
O. pendens, *Blake.*

GIRVAN DISTRICT.

This district embraces an area in the extreme northwest part of the tableland, extending along the shore from Girvan to the mouth of Glen App, and inland to the village of Barr in the valley of the Stinchar.

The geological structure of the area south of the Stinchar closely resembles that already described in the Sanquhar and Leadhills districts; for there we find a sequence from the Arenig volcanic rocks and overlying Radiolarian cherts and graptolitic mudstones with Glenkiln graptolites upwards to the greywackes, shales and conglomerates of Llandeilo-Caradoc age. (Portandea and Currarie north of Glen App.)

North of the Stinchar valley, however, the sequence is wholly different. One of the striking features of this northern area is the remarkable development of Arenig volcanic rocks near Ballantrae, comprising diabase and diabase porphyrite lavas, agglomerates and tuffs. The age of this volcanic series is clearly defined by the occurrence in it of black shales and cherty mudstones yielding graptolites of Lower or Middle Arenig age. North of the Stinchar valley they are overlain by a great development of Radiolarian cherts (Arenig and Lower Llandeilo) and other sediments. The lavas, tuffs and overlying sediments are pierced by various intrusive igneous rocks, including serpentine, gabbro, dolerite, diorite, and granite. Of special importance also is the marked unconformability that separates the rocks just described from the overlying sedimentary series of Girvan. For the massive conglomerates (Kirkland and Benan) at the base of the latter series not only rest on the eroded surfaces of the volcanic and plutonic rocks, but are mainly composed of materials derived from the underlying platform.

The general succession and subdivisions of the Girvan series, as worked out by Professor Lapworth, are given in the following table, from which it will be seen that there is a marked divergence in the lithological characters of the strata from those in the Central Moffat region. In most of the subdivisions there is a great development of coarse sediments consisting of conglomerates, grits, greywackes, flagstones, mudstones, and shales, implying deposition near land and in comparatively shallow water. As might be expected from the foregoing conditions the Girvan series yields organic remains in profusion, on certain horizons. Of special importance are the bands of graptolite shales, yielding many of the zonal forms of the Moffat region, which enabled Professor Lapworth to correlate the Silurian divisions of the Girvan and Moffat areas. (See general Table, pp. 424, 425.)

The list of fossils from the Girvan area, exclusive of the graptolites, has been compiled from all obtainable sources, and is, in large measure, based on the general list and on Mrs. Gray's list of fossils published in the Geological Survey Memoir on "The Silurian Rocks of Scotland." Special thanks are due to Mrs. Gray for supplying a note of recent additions to her list, which now appear for the first time. Want of space has prevented the insertion of more than one or two localities for each fossil. When two localities are given, they represent the lowest and highest horizons for each form.

In this list each division of the Silurian system is represented by a capital letter, each sub-division by a figure.

TABLE OF SILURIAN STRATA, GIRVAN.

F. Wenlock.	1. Blair and Straiton Beds.—Grits, flags, and shales. *Beyrichia Kloedeni.*	Thickness, 500 feet.
E. Tarannon.	2. Drumyork Flags, Bargany Group.—Shales, etc. *Cyrtograptus Grayi, Monograptus priodon.*	1100 feet.
	1. Penkill Group.—Grits, purple shales. *Monograptus exiguus, Crossopodia.*	1000 feet,
D. Llandovery.	3. Camregan Group.—Grits, limestones, shales. *Rastrites maximus, Pentamerus.*	200 feet.
	2. Saugh Hill Group.—Flagstones, shales. *Monograptus spinigerus, Rastrites peregrinus.*	500 feet.
	1. Mulloch Hill Group.—Conglomerate, sandstone, shales. *Diplograptus acuminatus, Meristella.*	350 feet.
C. Caradoc.	ARDMILLAN SERIES.	
	5. Drummuck Group.—Mudstones. *Dicellograptus anceps, Trinucleus.*	400 feet.
	4. Barren Flagstone Group. *Diplograptus truncatus, Nematolites.*	800 feet.
	3. Whitehouse Group. *Dicellograptus, Pleurograptus, Trilobites.*	300 feet.
	2. Ardwell Group.—Flagstones, shales. *Climacograptus caudatus, Dicranograptus.*	1200 feet.
	1. Balclatchie Group.—Mudstones, conglomerate. *Climacograptus bicornis.* Fossils abundant.	100 feet.
B. Llandeilo. Area N. of Stinchar.	BARR SERIES.	
	4. Benan conglomerate.	Thickness, 500 feet.
	3. Graptolitic Mudstones. *Didymograptus superstes.*	30 feet.
	2. Stinchar Limestone. Trilobites, brachiopods, corals.	60 feet.
	1. Kirkland Group.—Sandstones, conglomerate. *Orthis confinis.* Local unconformability.	240 feet.
A. Arenig.	3. Radiolarian Cherts, mudstones, volcanic tuffs, Arenig and Lower Llandeilo cherts.	70 feet.
	2. Bennane Head Black Shales. Interleaved with volcanic agglomerate. *Tetragraptus bryonoides.*	3-4 feet.
	1. Volcanic rocks, lavas, tuffs, with fossiliferous intercalations. Base not seen.	Approximate thickness, 1500 feet.

FOSSILS FROM THE SILURIAN ROCKS OF GIRVAN.

Species.	Locality.	Range.
PLANTAE (?).		
Chondrites verisimilis, *Salt.*	Bargany Pond Burn.	D3.
ALGAE (?).		
Girvanella problematica, *Nicholson & Etheridge.*	Tramitchell.	B2.
RHIZOPODA (?).		
Nidulites favus, *Salt.*	Balclatchie; Mulloch Hill.	C1-D1
FORAMINIFERA.		
Saccammina Carteri, *Brady.*	Craighead; Tramitchell.	B2.
RADIOLARIA.		
Radiolaria (abundant).	Bennane Head; Currarie.	A2.
SPONGIDA.		
Hyalostelia girvanense, *N. & E.*	Knockgerran.	C2
Ischadites antiquus, *Salt.*	Woodland Point; Penkill.	D2-E1.
I. Koenigi, *Murch.*	Balclatchie.	C1.
HYDROZOA.		
Clathrodictyon vesiculosum, *N. and Murie.*	Woodland Point.	D2.
Gorgonia regularis, *Portl.*	Woodland Point.	D2.
COELENTERATA.		
Aulacophyllum mitratum, *His,*	Mulloch Hill.	D1.
Calostylis Lindströmi, *N. and E.*	Penkill.	D3.
Chaetetes, sp.	Mulloch Hill.	D1.
Favosites asper, *d'Orb.*	Balclatchie; Rough Neuk.	C1-D1.
F. girvanensis, *N. and E.*	Craighead.	B2.
F. gothlandicus, *Fougt.*	Rough Neuk.	D1.
F. mullochensis, *N. and E.*	Mulloch Hill.	D1-D2.
Fistulipora favosa, *N. and E.*	Balclatchie.	C1.
F. pilula, *N. and E.*	Craighead.	B2.
Halysites catenulatus, *Linn.*	Craighead; Mulloch Hill.	B2-D1.
Heliolites foliaceus, *N. and E.*	Woodland Point.	D2.
H. Grayi, *Edw. and Haime.*	Craighead.	B2.
H. interstinctus, *Linn.*	Mulloch Hill; Penkill.	D1-E1.
H. parasiticus, *N. and E.*	Threave; Craigens.	C5-D1.
H. tubulatus, *Lonsd.*	Rough Neuk.	D1.
Labechia canadensis, *N. & Murie.*	Aldons.	B2.
Lindströmia subduplicata, *M'Coy.*	Craighead; Mulloch.	B2-D1.
Lyopora favosa, *M'Coy.*	Craighead.	B2.
Monticulipora girvanensis, *Nich.*	Craighead.	B2.
Palaeocyclus, sp.	Rough Neuk.	D1.
Petraia bina, *Lonsd.*	Rough Neuk.	D1.
P elongata, *Phil.*	Rough Neuk.	D1.
Pinacopora Andersoni, *N. and E.*	Woodland Point.	D2.
P. Grayi, *N. and E.*	Mulloch; Newlands.	D1-D2.
Plasmopora girvanensis, *N. & E.*	Woodland Point.	D2.
Prasopora Grayae, *N. and E.*	Craighead.	B2.
Propora Edwardsi, *N. and E.*	Craighead.	B2.

Stenopora fibrosa, *Goldf.*	Craighead.	B2.
Streptelasma aequisulcatum, *M'Coy.*	Mulloch Hill.	D1.
S. aggregatum, *N. and E.*	Craighead.	B2.
S. Craigense, *M'Coy.*	Craighead.	B2.
S. europaeum, *Röm.*	Craighead.	B2.
Stylarea occidentalis, *N. & E.*	Craighead.	B2.
Tetradium Peachi, *N. & E.*	Craighead ; Bougang.	B2.
Thecostegites scoticus, *N. and E.*	Craighead.	B2.

ASTEROIDEA.

Palaeaster, sp.	Dow Hill.	C1.
Tetraster Wyv-Thomsoni, *E. & N.*	Threave, Starfish Bed.	C5.

CYSTOIDEA.

Echinosphaerites granulatus, *M'Coy.*	Trochrague Burn.	B3.
Pleurocystites sp.	Threave.	C5.

CRINOIDEA.

Crinoid stems.	Craighead ; Straiton.	B2-F1
Myelodactylus sp.	Penkill.	D3.

ANNELIDA.

Cornulites sp.	Craighead.	B2.
Crossopodia scotica, *M'Coy.*	Penwhapple Glen.	E1.
Eione ? sp.	Penwhapple Glen.	E1.
Myrianites tenuis, *M'Coy.*	Penwhapple Glen.	E1.
Nemertites, sp.	Penwhapple Glen.	E1.
Nereites cambrensis, *Murch.*	Penwhapple Glen.	E1.
Olnencites sp. (jaws of).	Balclatchie.	C1.
Serpulites longissimus, *Murch.*	Minuntion ; Threave.	B2-C5.
Tentaculites anglicus, *Salt.*	Shalloch Mill ; Camregan.	C3-E1.
T. ornatus, *Sow.*	Tramitchell ; Woodland Point.	B2-D2.

CIRRIPEDIA.

Turrilepas Peachi, *N. and E.*	Whitehouse Bay.	C3.
T. scotica, *N. and E.*	Balclatchie.	C1.
T. Wrighti, *Woodw.*		

OSTRACODA.

Aparchites leperditioides, *J.*	Whitehouse Bay.	C3.
A. subovatus, *J.*	Whitehouse Bay.	C3.
Beyrichia comma, *J.*	Threave.	C5.
B. impar, *J.*	Whitehouse Bay.	C3.
B. impendens, *Jones.*	Straiton.	F1.
B. Kloedeni, *M'Coy.*	Threave ; Straiton.	C5-F1.
B. Kloedeni, var. **infecta,** *J.*	Whitehouse Bay.	C3.
B. Kloedeni, var. **scotica,** *J. and Holl.*	Bargany Pond Burn.	D3.
Cythere aldensis, *M'Coy.*	Aldons.	B2.
C. aldensis, var. **major,** *J.*	Aldons.	B2.
C. Grayana, *J.*	Aldons.	B2.
C. Wrightiana, *J. and Holl.*	Aldons.	B2.
Cypridina Grayae, *J.*	Whitehouse Bay.	C3.
Entomis globulosa, *J.*	Straiton.	F1.
Primitia Barrandiana, *J.*	Aldons.	B2.
P. elongata, var. **nuda,** *J.*	Whitehouse Bay.	C3.

Primitia girvanensis, *J.*	Whitehouse Bay.	C3.
P. Grayae, *J.*	Whitehouse Bay.	C3.
P. Krausei, *J.*	Whitehouse Bay.	C3.
P. mundula, var. **fimbriata,** *J.*	Whitehouse Bay.	C3.
P. mundula, var. **Kloedeniana,** *J.*	Whitehouse Bay.	C3.
P. ulrichiana, *J.*	Whitehouse Bay.	C3.
Sulcuna praeurrens, *Jones.*	Whitehouse Bay.	C3.
Ulrichia girvanensis, *Jones.*	Whitehouse Bay.	C3.
U. Grayae, *Jones.*	Whitehouse Bay.	C3.

PHYLLOCARIDA.

Caryocaris Wrighti, *Salt.*	Balcreuchan Port.	A1.
Discinocaris gigas, *Woodw.*	Blackwood Head.	E1.
Pinnocaris Lapworthi, *Eth. Jnr.*	Balclatchie.	C1.
Solenocaris solenoides, *Y.*	Threave.	C5.

TRILOBITA.

Acidaspis bispinosa, *M'Coy.*	Penkill.	D3.
A. Brighti, *Murch.*	Woodland Point.	D2.
A. Grayae, *Eth. Jnr.*	Balclatchie.	C1.
A. hystrix, *Wyv.-Thom.*	Balclatchie.	C1.
A. Lalage, *Wyv.-Thom.*	Balclatchie.	C1.
Agnostus agnostiformis, *M'Coy.*	Balclatchie ; Threave.	C1-C5.
A. perrugatus, *Barr.*	Whitehouse Bay.	C3.
Ampyx Hornei, *E. and N.*	Craighead ; Balclatchie.	B2-C1.
A. Maccallumi, *Salt.*	Balclatchie.	C1.
A. mammillatus, *Sars.*	Penwhapple Glen.	C.
A. nasutus, *Dalm.*	Penwhapple Glen.	C.
A. nudus, *Murch.*	Balclatchie.	C1.
A. rostratus, *Sars.*	Balclatchie ; Threave.	C1-C5.
Asaphus (Isotelus) gigas, *Dekay.*	Minuntion ; Balclatchie.	B2-C1.
A. marginatus, *Portl.*	Threave.	C5.
A. rectifrons, *Portl.*	Bougang ; Balclatchie.	B2-C1.
Barrandia sp.	Balclatchie.	C1.
Bohemilla sp.	Whitehouse Bay.	C3.
Bronteopsis scotica, *Salt.*	Balclatchie ; Ardmillan.	C1.
Bronteus Andersoni, *E. and N.*	Penkill.	D3.
B. hibernicus, *Portl.*	Threave (?)	C5.
Calymene Blumenbachi, *Brong.*	Craighead ; Straiton.	B2-F1.
C. tuberculosa, *Salt.*	Threave.	C5.
Cheirurus bimucronatus, *Murch.*	Craighead ; Penkill Burn.	B2-E1.
C. clavifrons, *Dalm.*	Threave.	C5.
C. gelasinosus, *Portl.*	Craighead ; Balclatchie.	B2-C1.
C. Sedgwicki, *M'Coy.*	Balclatchie.	C1.
C. trispinosus, *Young.*	Penkill.	D3.
Cybele rugosa, *Portl.*	Threave.	C5.
C. verrucosa, *Dalm.*	Balclatchie ; Dow Hill.	C1.
Cyclopyge armata, *Barr.*	Whitehouse Bay.	C3.
C. rediviva, *Barr.*	Whitehouse Bay.	C3.
Deiphon Forbesi, *Barr.*	Balclatchie.	C1.
Dindymene Cordai, *E. and N.*	Whitehouse ; Drummuck.	C3-C5.
Dionide Lapworthi, *E. and N.*	Whitehouse ; Threave.	C3-C5.
Encrinurus punctatus, *Brün.*	Penkill ; Straiton.	D3-F1.
E. punctatus, var. **arenaceus,** *Salt.*	Craighead ; Straiton.	B2-F1.
E. punctatus, var. **calcareus,** *Salt.*	Craighead ; Penkill.	B2-D3.

Harpes sp.	Aldons; Bargany Pond Burn.	B2-D3.
Illaenus (Dysplanus) aemulus, *Salt.*	Penkill.	D3.
I. (Bumastus) Barriensis, *Murch.*	Woodland Point.	D2.
I. (B.) Bowmani, *Salt.*	Craighead; Balclatchie.	B2-C1.
I. (B.) Maccallumi, *Salt.*	Drummuck.	C5.
I. latus ? *M'Coy.*	Minuntion.	B2.
I. Murchisoni, *Salt.*	Penkill.	D3.
I. nexilis, *Salt.*	Drummuck; Penkill.	C5 D3.
I. Rosenbergi, *Eichw.*	Craighead; Penkill.	B2-D3.
I. Thomsoni, *Salt.*	Mulloch; Woodland.	D1-D2.
I. sp.	Shalloch Mill; Camregan.	C3-D3.
Lichas ambiguus, *Barr.*	Mulloch Hill; Newlands.	D1-D2.
L. Barrandei, *Flet.*	Mulloch Hill.	D1.
L. Geikiei, *E. and N.*	Threave.	C5.
L. Grayi, *Flet.*	Balclatchie.	C1.
L. hibernicus, *Portl.*	Craighead; Balclatchie.	B2-C1.
L. laxatus, *M'Coy.*	Threave.	C5.
L. palmatus, *Barr.*	Mulloch Hill.	D1.
L. sp.	Dow Hill; Camregan.	C1-D3.
Phacops (Acaste) Brongniarti, *Portl.*	Bougang; Threave.	B2 C5.
P. (A.) Downingiae, *Murch.*	Mulloch Hill; Straiton.	D1-F1.
P. (A.) Stokesi, *M. Edw.*	Mulloch Hill; Straiton.	D1-F1.
Phillipsia parabola, *Barr.*	Threave Glen.	C5.
Proetus girvanensis, *E. and N.*	Balclatchie; Threave.	C1-C5.
P. latifrons, *M'Coy.*	Threave.	C5.
P. procerus, *E. and N.*	Threave.	C5.
P. Stokesi, *Murch.*	Straiton.	F1.
Remopleurides Barrandei, *E. & N.*	Balclatchie.	C1.
R. Colbii, *Portl.*	Minuntion; Threave.	B2-C5.
R. dorsospinifer, *Portl.*	Ardmillan.	C1.
R. laterispinifer, *Portl.*	Minuntion; Balclatchie.	B2-C1.
Salteria primaeva, *Wyv.-Thom.*	Balclatchie.	C1.
Sphaerexochus mirus, *Beyr.*	Craighead; Balclatchie.	B2-C1.
Staurocephalus globiceps, *Portl.*	Balclatchie; Woodland Point.	C1-D2.
S. unicus, *Wyv.-Thom.*	Balclatchie; Mulloch.	C1-C5.
Stygina latifrons, *Portl.*	Ardmillan.	C1.
Trinucleus Bucklandi, *Barr.*	Drummuck.	C5.
T. concentricus, *Eaton.*	Dow Hill.	C1.
T. Macconochiei, *E. and N.*	Balclatchie.	C1.
T. ornatus, *Stern.*	Balclatchie.	C1.
T. seticornis, *His.*	Drummuck.	C5.

POLYZOA.

Fenestella assimilis, *Lonsd.*	Woodland Point.	D2.
F. Milleri, *Lonsd.*	Woodland Point.	D2.
F. patula, *M'Coy.*	Woodland Point; Penkill.	D2-D3.
F. subantiqua. *d'Orb.*	Woodland Point; Penkill.	D2-D3.
Glauconome disticha, *Goldf.*	Woodland Point.	D2.
Hippothoa inflata, *Nich.*	Woodland Point.	D2.
Ptilodictya costellata, *M'Coy.*	Mulloch Hill.	D1.
P. dichotoma, *Portl.*	Balclatchie; Penkill.	C1-E1.
P. lanceolata, *Goldf.*	Woodland; Straiton.	D2-F1.
Retepora sp.	Balclatchie; Rough Neuk.	C1-D1.
Rhinopora verrucosa, *Hall.*	Woodland Point.	D2.

BRACHIOPODA.

Acrothele granulata, *Linnr.*	Dow Hill.	C1.
Acrotreta costata (?) *Dav.*	Balclatchie.	C1.
A. Nicholsoni, *Dav.*	Craighead ; Balclatchie.	B2-C1.
Athyris sp.	Whitehouse Bay.	C3.
Atrypa (Leptocoelia) hemispherica, *Sow.*	Mulloch ; Camregan.	D1-D3.
A. imbricata, *Sow.*	Threave ; Penkill.	C5-D3.
A. marginalis, *Dalm.*	Penwhapple.	D.
A. reticularis, *Linn.*	Mulloch ; Straiton.	D1-F1.
A. scotica, *M'Coy.*	Mulloch Hill.	D1.
Crania llandoveriana, *Dav.*	Newlands.	D2.
C. siluriana, *Dav.*	Mulloch ; Woodland Point.	D1-D2.
Cyrtia exporrecta, *Wahl.*	Penkill.	D3.
Discina crassa, *Hall.*	Penwhapple ; Straiton.	E1-F1.
D. oblongata, *Portl.*	Balclatchie.	C1.
D. perrugata, *M'Coy.*	Craighead ; Threave.	B2-C5.
D. rugata, *Sow.*	Bargany Pond Burn.	D3.
Glassia (Athyris) obovata, *Sow.*	Penkill.	D3.
Kutorgina sp.	Bennane Head.	A2.
Leptaena (Plectambonites) cornuta, *Dav.*	Ardmillan.	C1.
L. Etheridgei, *Dav.*	Craighead.	B2.
L. Grayi, *Dav.*	Craighead.	B2.
L. llandeiloensis, *Dav.*	Craighead ; Ardmillan.	B2-C1.
L. (Plectambonites quinquecostata, *M'Coy.*)	Ardmillan : Woodland Point.	C1-D2.
L. scissa, *Salt.*	Ardmillan ; Woodland Point.	C1-D2.
L. segmentum, *Angelin.*	Shalloch Mill ; Cuddystone Glen.	C3-D3.
L. sericea, *Sow.*	Craighead ; Penkill.	B2-D3.
L. sericea, var. **rhombica,** *M'Coy.*	Craighead ; Balclatchie.	B2-C1.
L. (Christiania) tenuicincta, *M'Coy.*	Balclatchie ; Shalloch Mill.	C1-C3.
L. (Plectambonites) transversalis, *Wahl.*	Craighead ; Penkill.	B2-D3.
L. Youngiana, *Dav.*	Craighead ; Balclatchie.	B2-C1.
Lingula attenuata, *Sow.*	Balclatchie ; Drummuck.	C1-C5.
L. brevis, *Portl.*	Ardmillan ; Whitehouse.	C1-C3.
L. canadensis, *Bill.*	Balclatchie.	C1.
L. granulata, *Phil.*	Minuntion ; Ardmillan.	B2-C1.
L. ovata, *M'Coy.*	Craighead ; Rough Neuk.	B2-D1.
L. quadrata, *Eichw.*	Craighead ; Threave.	B2-C5.
L. Ramsayi, *Salt.*	Craighead ; Benan Burn.	B2-B3.
L. Symondsi, *Salt.*	Woodland ; Straiton.	D2-F1.
Lingulella Davisi, *M'Coy.*	Auchensoul.	B2.
L. lepis, *Salt.*	Portandea.	B.
Linnarssonia (Obolella) sagittalis (*Salt.*).	Balcreuchan Port.	A1.
Merista cymbula, *Dav.*	Drummuck ; Threave.	C5.
Meristella angustifrons, *M'Coy.*	Mulloch Hill.	D1.
M. (Whitfieldia) tumida, *Dalm.*	Bargany Pond Burn.	D3.
Nucleospira pisum, *Sow.*	Bougang ; Bargany Pond Burn.	B2-D3.
Obolella sp.	Bennane Head.	A2.
Orbiculoidea Forbesi, *Dav.*	Mulloch ; Woodland Point.	
Orthis Actoniae, *Sow.*	Shalloch Mill ; Threave.	C3-C5.
O. alternata, *Sow.*	Benan Burn.	B1.

Orthis (Platystrophia) biforata, *Schl.*	Craighead; Straiton.	B2-F1.
O. (Bilobites) biloba, *Linn.*	Shalloch Mill; Bargany Pond Burn.	C3-D3.
O. Bouchardi, *Dav.*	Straiton.	F1.
O. balcletchiensis, *Dav.*	Craighead; Balclatchie.	B2-C1.
O. calligramma, *Dalm.*	Craighead; Penwhapple.	B2-E1.
O. calligramma, var. **plicata,** *Sow.*	Balclatchie; Woodland Point.	C1-D2.
O. calligramma, var. **scotica,** *Dav.*	Craighead.	B2.
O. calligramma, var. **virgata,** *Salt.*	Dularg; Balclatchie.	B2-C1.
O. Carausii, *Salt.*	Ardmillan.	C1.
O. confinis, *Salt.*	Benan Burn; Minuntion.	B1-B2.
O. crispa, *M'Coy.*	Ardmillan; Threave.	C1-C5.
O. (Dalmanella) elegantula, *Dalm.*	Craighead; Straiton.	B2-F1.
O. (Dinorthis) flabellulum, *Sow.*	Craighead; Straiton.	B2-F1.
O. girvanensis, *Dav.*	Craighead.	B2.
O. intercostata, *Portl.*	Aldons; Trochrague.	B2-B3.
O. kilbuchoensis, *Dav.*	Ardmillan.	C1.
O. Lapworthi, *Dav.*	Balclatchie; Shalloch Mill.	C1-C3.
O. mullochiensis, *Dav.*	Threave; Mulloch.	C5-D1.
O. nina, *Dav.*	Whitehouse Bay.	C3.
O. polygramma, *Sow.*	Camregan.	D3-E1.
O. polygramma, var. **pentlandica,** *Dav.*	Balclatchie; Penkill.	C1-D3.
O. porcata, *M'Coy.*	Threave.	C5.
O. protensa, *Sow.*	Benan Crag.	B2.
O. Rankini, *Dav.*	Ardmillan; Threave.	C1-C5.
O. reversa, *Salt.*	Penkill.	E1.
O. rustica, *Sow.*	Mulloch; Straiton.	D1-F1.
O. rustica, var. **rigida,** *Dav.*	Woodland; Penkill.	D2-D3.
O. saggittifera, *M'Coy.*	Mulloch Hill.	D1.
O. Sowerbyana, *Dav.*	Craighead; Threave.	B2-C5.
O. (Dalmanella) testudinaria, *Dalm.*	Craighead; Shalloch Mill.	B2-C3.
O. tricenaria, *Conr.*	Piedmont Glen.	C2.
O. turgida, *M'Coy.*	Craighead; Penkill.	B2-E1.
O. vespertilio, *Sow.*	Craighead; Shalloch Mill.	B2-C3.
Orthisina (Clitambonites) Grayae, *Dav.*	Shalloch Mill; Threave.	C2-C5.
O. (C.) scotica, *M'Coy.*	Bougang.	B2.
Paterula balcletchiensis, *Dav.*	Balclatchie; Threave.	C1-C5.
Pentamerus galeatus, *Sow.*	Penkill.	D3.
P. globosus, *Sow.*	Penkill.	D3.
P. oblongus, *Sow.*	Newlands; Blackwood.	D2-E1.
P. oblongus, var. **laevis,** *Sow.*	Penwhapple.	D3.
P. rotundus, *Sow.*	Penkill.	D3-E1.
P. shallochiensis, *Dav.*	Shalloch Mill.	C3.
P. undatus, *Sow.*	Mulloch; Penkill.	D1-D3.
Pholidops implicata, *Sow.*	Shalloch Mill; Penkill.	C3-D3.
Porambonites intercedens, *Pand.*	Shalloch Mill.	C3.
Retzia Barrandei, *Dav.*	Straiton.	F1.
Rhynchonella aemula, *Salt.*	Craighead.	B2.
R. ardmillanensis, *Dav.*	Ardmillan.	C1.
R. balcletchiensis, *Dav.*	Craighead; Balclatchie.	B2-C1.
R. cuneata, *Dalm.*	Auldthorns; Camregan.	C5-D3.
R. cuneatella, *Dav.*	Balclatchie.	C1.
R. decemplicata, *Sow.*	Mulloch Hill.	D1.
R. girvanensis, *Dav.*	Balclatchie.	C1.

Rhynchonella Lapworthi, *Dav.*	Craighead.	B2.
R. llandoveriana, *Dav.*	Camregan Wood.	D3.
R. micula, *Sow.*	Shalloch Mill.	C3.
R. nasuta, *M'Coy.*	Craighead; Balclatchie.	B2-C1.
R. nucula, *Sow.*	Balclatchie: Shalloch Mill.	C2-C3.
R. Peachi, *Dav.*	Craighead; Threave.	B2-C5.
R. (Hyattella) Portlockiana, *Dav.*	Craighead; Balclatchie.	B2-C1.
R. Salteri, *Dav.*	Craighead; Ardmillan.	B2-C1.
R. scotica, *Dav.*	Craighead.	B2.
R. shallochiensis, *Dav.*	Shalloch Mill.	C3.
R. sub-borealis, *Dav.*	Craighead.	B2.
R. Thomsoni, *Dav.*	Craighead.	B2.
R. Thomsoni, var. ?		
R. Weaveri, *Salt.*	Craighead.	B2.
R. Wilsoni, *Sow.*	Camregan Wood.	D3.
Siphonotreta anglica, *Morris.*	Barr; Straiton.	B2-F1.
S. micula, *M'Coy.*	Balclatchie.	C1.
S. scotica, *Dav.*	Craighead; Threave.	B2-C5.
Skenidium Grayi, *Dav.*	Threave.	C5.
S. Lewisi, *Dav.*	Craighead; Threave.	B2-C5.
S. shallochiensis, *Dav.*	Shalloch Mill.	C3.
S. woodlandiensis, *Dav.*	Woodland Point.	D2.
Spirifera crispa, *His.*	Bargany Pond Burn.	D3.
S. plicatella, *Linn.*	Bargany Pond Burn.	D3.
S. plicatella, var. **radiata,** *Sow.*	Bargany Pond Burn; Penkill.	D3-E1.
S. sulcata, *His.*	Straiton.	F1.
Stricklandinia balcletchiensis,	Balclatchie.	C1.
S. lens, *Sow.*	Mulloch; Penwhapple.	D1-E1.
S. lirata, *Sow.*	Woodland Point.	D2.
Strophomena antiquata, *Sow.*	Mulloch; Penkill.	D1-E1.
S. applanata, *Salt.*	Newlands; Penkill.	D2-E1.
S. arenacea, *Salt.*	Woodland Point; Camregan.	D2-D3.
S. compressa, *Sow.*	Ardmillan; Camregan.	C1-D3.
S. corrugatella, *Dav.*	Craighead; Woodland Point.	B2-D2.
S. (Rafinesquina) deltoidea, *Conr.*	Craighead; Woodland Point.	B2-D2.
S. (R.) expansa, *Sow.*	Craighead; Mulloch.	B2-D1.
S. Grayae, *Dav.*	Craighead.	B2.
S. grandis, *Sow.*	Threave.	C5.
S. imbrex, *Pand.*	Balclatchie.	C1.
S. imbrex, var. **semiglobosa,** *Dav.*	Craighead; Balclatchie.	B2-C1.
S. insculpta, *Hall.*	Ardmillan.	C1.
S. llandeiloensis, *Dav.*	Craighead; Ardmillan.	B2-C1.
S. pecten, *Linn.*	Newlands; Woodland Point.	D2.
S. retroflexa, *Salt.*	Craighead; Dow Hill.	B2-C1.
S. rhomboidalis, *Wilck.*	Craighead; Penkill.	B2-E1.
S. shallochiensis, *Dav.*	Shalloch Mill; Threave.	C3-C5.
S. simulans, *M'Coy.*	Shalloch Mill; Rough Neuk.	C3-D1.
S. undata, *M'Coy.*	Dow Hill; Bargany Pond Burn.	C1-D3.
S. Walmstedti, *Linds.*	Cuddystone Glen.	D3.
S. Waltoni, *Dav.*	Cuddystone Glen.	D3.
Triplesia Grayae, *Dav.*	Craighead.	B2.
T. incerta, *Dav.*	Penkill.	D3.
T. Maccoyana, *Dav.*	Craighead.	B2.
T. monilifera, *M'Coy.*	Woodland Point.	D2.
T. spiriferoides, *M'Coy.*	Ardmillan; Threave.	C1-C5.

LAMELLIBRANCHIATA.

Ambonychia amygdalina, *Hall.*	Craighead ; Woodland.	B2-D2.
A. bellistriata, *Hall.*	Penkill.	D3.
A. orbicularis, *Conr.*	Mulloch ; Woodland.	D1-D2.
A. radiata, *Emm.*	Craighead ; Shalloch Mill.	B2-C3.
Arca Edmondiaeformis, *M'Coy.*	Ardmillan.	C1.
Avicula Danbyi, *M'Coy.*	Glenwells.	D1.
A. elliptica, *Hall.*	Woodland Point.	D2.
Cardiola fibrosa, *Sow.*	Penwhapple ; Straiton.	E1-F1.
C. striata, *Sow.*	Penkill.	D3.
Cleidophorus sp.	Kirkdominae.	B3.
Ctenodonta anglica, *d'Orb.*	Balclatchie.	C1.
C. astartaeformis, *Salt.*	Ardmillan ; Dow Hill.	C1.
C. Eastnori, *Murch.*	Threave.	C5.
C. levata, *Hall.*	Balclatchie.	C1.
C. (Nucula) subacuta, *M'Coy.*	Balclatchie.	C1.
C. varicosa, *Salt.*	Ardmillan.	C1.
Cucullella sp.	Straiton.	F1.
Goniophora cymbaeformis, *Sow.*	Woodland Point ; Penkill.	D2-D3.
Grammysia sp.	Straiton.	F1.
Lunulicardium elegans, *Salt.*	Penwhapple.	E1.
Modiolopsis modiolaris, *Conr.*	Ardmillan.	C1.
Mytilus gradatus, *Salt.*	Shalloch Mill.	C3.
M. mytilimeris, *Conr.*	Woodland Point ; Penkill.	D2-D3.
M. semirugatus, *Portl.*	Penkill.	D3.
Orthonota contracta, *Hall.*	Craighead.	B2.
O. prora, *Salt.*	Threave,	C5.
O. rigida, *Sow.*	Camregan.	D3.
O. semisulcata, *Sow.*	Mulloch Hill.	D1.
O. simplex, *Portl.*	Mulloch Hill.	D1.
O. truncata, *Sow.*	Straiton.	F1.
O. undata, *Sow.*	Mulloch ; Newlands.	D1-D2.
Palaearca modiolaris, *Salt.*	Mulloch Hill.	D1.
P. quadrata, *Salt.*	Mulloch Hill.	D1.
Pleurorhynchus (Conocardium) dipterus, *Salt.*	Craighead : Balclatchie.	B2-C1.
P. pristis, *Salt.*	Mulloch Hill.	D1.
Pterinea hyans, *M'Coy.*	Rough Neuk.	D1.
P. pleuroptera, *Conr.*	Straiton.	F1.
P. Sowerbyana, *M'Coy.*	Threave.	C5.
P. tenuistriata, *M'Coy.*	Camregan.	D3.

GASTEROPODA.

Bellerophon acutus, *Sow.*	Craighead ; Ardmillan.	B2-C1.
B. argo, *Bill.*	Shalloch ; Threave.	C3-C5.
B. bilobatus, *Sow.*	Ardmillan ; Threave.	C1-C5.
B. carinatus, *Sow.*	Shalloch ; Threave.	C3-C5.
B. dilatatus, *Sow.*	Mulloch ; Woodland.	D1-D2.
B. elongatus, *Portl.*	Threave.	C5.
B. expansus, *Sow.*	Ardmillan ; Penkill.	C1-D3.
B. fastigiatus, *Linds.*	Bougang.	B2.
B. perturbatus, *Sow.*	Drummuck.	C5.
B. punctifrons, *Emm.*	Craighead.	B2.
B. sphaera, *Linds.*	Woodland Point.	D2.
B. squamosus, *Linds.*	Threave ; Mulloch Hill.	C5-D1.
B. subdecussatus, *M'Coy.*	Drummuck ; Mulloch.	C5-D1.

Bellerophon trilobatus, *Sow.*	Ardmillan ; Threave.	C1-C5.
B. Urei (?), *Flem.*	Drummuck.	C5.
B. wenlockensis, *Sow.*	Mulloch Hill.	D1.
Bucania profunda, *Hall.*	Craighead.	B2.
Chelodes (Helminthochiton) Grayae, *Woodw.*	Threave Glen.	C5.
Cyclonema carinatum, *Sow.*	Shalloch Mill.	C3.
C. crebristria, *M'Coy.*	Ardmillan.	C1.
Cyrtolites euryomphalus, *Linds.*	Newlands.	D2.
C. orbiculus, *Linds.*	Balclatchie.	C1.
Ecculiomphalus Bucklandi, *Portl.*	Craighead ; Shalloch Mill.	B2-C3.
E. laevis, *Sow.*	Craighead ; Shalloch Mill.	B2-C3.
E. minor, *Portl.*	Ardmillan.	C1.
E. scoticus, *M'Coy.*	Ardmillan.	C1.
Euomphalus funatus, *Sow.*	Shalloch Mill.	C3.
E. granulatus, *Portl.*	Mulloch.	D1.
Fusispira elongata, *Hall.*	Woodland Point.	D2.
Holopea lymnaeoides, *Forbes.*	Threave.	C5.
H. paludiniformis, *Hall.*	Craighead.	B2.
Holopella obsoleta, *Sow.*	Threave ; Mulloch.	C5-D1.
H. tenuicincta, *M'Coy.*	Mulloch Hill.	D1.
Loxonema elegans, *M'Coy.*	Threave.	C5.
L. sinuosum, *Sow.*	Drummuck.	C5.
Maclurea Logani, *Salt.*	Craighead ; Bougang.	B2.
M. Maccoyi, *Salt.*	Minuntion.	B2.
M. (Ophileta) macromphala, *M'Coy.*	Craighead ; Minuntion.	B2.
M. magna, *Lesu.*	Aldons ; Minuntion.	B2.
M. matutina, *Hall.*	Balclatchie.	C1.
Macrochilina elongata, *Portl.*	Mulloch Hill.	D1.
Metoptoma sp.	Craighead.	B2.
Murchisonia angulata, *Phil.*	Bougang.	B2.
M. cancellatula, *M'Coy.*	Mulloch Hill.	D1.
M. elongata, *Portl.*	Rough Neuk.	D1.
M. (Ectomaria ?) exigua, *Donald.*	Minuntion.	B2.
M. (E.) girvanensis, *Donald.*	Minuntion.	B2.
M. gracilis, *Hall.*	Minuntion.	B2.
M. (Hormotoma) Grayana, *Don.*	Woodland Point.	D2.
M. gyrogonia, *M'Coy.*	Bougang ; Balclatchie.	B2-C1.
M. obscura, *Portl.*	Threave.	C5.
M. pulchra, *M'Coy.*	Drummuck.	C5.
M. simplex, *M'Coy.*	Balclatchie.	C1.
M. (Pleurotomaria) turrita, *Portl.*	Drummuck.	C5.
M. vitellia, *Bill.*	Minuntion.	B2.
Ophileta compacta, *Salt.*	Balclatchie ; Threave.	C1-C5.
O. nerine, *Bill.*	Shalloch Mill.	C3.
O. sp.	Craighead.	B2.
Oriostoma angulatum, *Linds.*	Mulloch Hill.	D1.
O. discors, *Sow.*	Shalloch Mill.	C3.
Platyceras cornutum, *His.*	Newlands ; Camregan.	D2-D3.
P. (Acroculia) haliotis, *Sow.*	Threave.	C5.
Platyschisma (Trochus) helicites, *Sow.*	Threave.	C5.
Pleurotomaria alata, *Wahl.*	Drummuck ; Woodland.	C5-D2.
P. aequilatera, *Wahl.*	Drummuck.	C5.

Pleurotomaria claustrata, *Linds.*	Mulloch Hill.	D1.
P. (Raphistoma) lenticularis.	Minuntion.	B2.
P. Milleri *Rogers*=**P. bicincta,** *Hall.*	Minuntion.	B2.
P. Moorei, *Salt.*	Mulloch Hill.	D1.
P. (Euomphalus) qualteriata, *Schl.*	Minuntion ; Newlands.	B2-D2.
P. scutulata, *Linds.*	Woodland Point.	D2.
P. trochiformis, *Portl.*	Ardmillan.	C1.
Raphistoma aequalis, *Salt.*	Balclatchie.	C1.
R. planistria, var. **parva,** *Hall.*	Threave.	C5.
Tremanotus sp.	Threave.	C5.
Trochus Moorei, *M'Coy.*	Mulloch Hill.	D1.
Trochonema sp.	Mulloch Hill.	D1.

PTEROPODA (?).

Conularia aspersa, *Linds.*	Woodland Point.	D2.
C. bilineata, *Linds.*	Threave ; Mulloch.	C5-D1.
C. elongata, *Portl.*	Craighead ; Dow Hill.	B2-C1.
C. Sowerbyi, *Def.*	Craighead.	B2.
C. subtilis, *Salt.*	Woodland Point.	D2.
Hyolithes acutus, *Eichw.*	Balclatchie.	C1.
H. corrugatus, *Salt.*	Drummuck.	C5.
H. elegans, *Barr.*	Threave.	C5.
H. (Theca) operculatus, *Salt.*	Balclatchie.	C1.
H. reversus, *Salt.*	Balclatchie ; Threave.	C1-C5.
H. triangularis, *Portl.*	Ardmillan ; Threave.	C1-C5.
H. vaginulus, *Salt.*	Ardmillan ; Threave.	C1-C5.
Pterotheca corrugata, *Salt.*	Balclatchie.	C1.
P. transversa, *Salt.*	Ardmillan.	C1.

CEPHALOPODA.

Cyrtoceras annulatum, *Hall.*	Mulloch Hill.	D1.
C. arcuatum, *Hall.*	Woodland Point.	D2.
C. compressum, *Sow.*	Penkill.	D3.
C. inaequiseptum, *Portl.*	Minuntion.	B2.
C. multicameratum, *Hall.*	Bougang.	B2.
C. scoticum, *Blake.*	Craighead.	B2.
C. victor, *Barr* (?).	Threave.	C5.
Endoceras strangulatum, *Hall.*	Balclatchie ; Threave.	C1-C5.
E. trochleare, *His.*	Ardwell.	C2.
Gomphoceras cinctum, *Blake.*	Camregan.	D3.
G. crater, *Blake.*	Woodland Point.	D2.
Orthoceras angulatum, *Wahl.*	Threave ; Penkill.	C5-E1.
O. annulatum, *Sow.*	Penwhapple Glen.	E1.
O. arcuoliratum, *Hall.*	Shalloch Mill.	C3.
O. argus, *Barr.*	Drummuck.	C5.
O. Avelini, *Salt.*	Ardmillan.	C1.
O. bilineatum, *Hall.*	Craighead ; Shalloch Mill.	B2-C3.
O. bullatum, *Sow.*	Whitehouse Bay ; Woodland Point.	C3-D2.
O. calamiteum.	Knockgerran.	C2.
O. carinatum, *Münst.*	Ardwell.	C2.
O. distans, *Sow.*	Woodland Point.	D2.
O. fimbriatum, *Sow.*	Bargany Pond Burn.	D3.
O. fusiforme, *Hall.*	Penkill ; Penwhapple.	D3-E1.
O. gracile, *Portl.*	Shalloch Mill.	C3.
O. Grayi, *Blake.*	Bargany Pond Burn.	D3.
O. Grindrodi, *Blake.*	Penkill.	D3-E1.

Orthoceras ibex, *Sow.*	Ardmillan.	C1.
O. imbricatum, *Wahl.*	Threave ; Penkill.	C5-D3.
O. ludense, *Sow.*	Shalloch ; Threave.	C3-C5.
O. MacLareni, *Salt.*	Straiton.	F1.
O. mocktreense, *Sow.*	Woodland Point.	D2.
O. multicinctum, *Hall.*	Penkill.	D3.
O. pendens, *Blake.*	Trochrague.	B3.
O. politum, *M'Coy.*	Pinmore ; Penwhapple.	B2-C2.
O. primaevum, *Forbes.*	Penkill.	D3.
O. subundulatum, *Portl.*	Dow Hill ; Straiton.	C1-F1.
O. tenuicinctum, *Portl.*	Mulloch ; Woodland.	D1-D2.
O. tracheale, *Sow.*	Woodland Point.	D2.
O. vagans, *Salt.*	Shalloch Mill ; Threave.	C3-C5.
O. vaginatum, *Schl.*	Ardwell.	C2.
Phragmoceras arcuatum, *Sow.*	Mulloch Hill.	D1.
Poterioceras sp.	Mulloch ; Penkill.	D1-D3.
Trochoceras aspersum, *Barr.* (?).	Woodland Point.	D2.
T. (Lituites) cornuarietes, *Sow.*	Mulloch Hill.	D1.
Trocholites planorbiformis, *Conr.*	Craighead.	B2.

LESMAHAGOW DISTRICT.

To the north of the margin of the Silurian tableland and within the area occupied by the Old Red Sandstone, there are several inliers of Upper Silurian strata, ranging from Wenlock to Downtonian time, which have been exposed at the surface by the folding and denudation of the younger Palaeozoic rocks. These may be grouped as follows :

1. The inlier near Lesmahagow (L in fossil list).
2. The inlier of the Hagshaw Hills (H in fossil list).
3. The inlier at Carmichael (C in fossil list).
4. The inlier south of Tinto.

Of the foregoing areas, by far the most important is that near Lesmahagow, where the strata are arranged in a gentle anticline, only the northern limb of which is preserved. The strata are admirably exposed in the Logan Water, Birkenhead Burn, and adjoining streams.

The passage-beds, comprising conglomerates and sandstones, with green and red mudstones, overlying comformably the Ludlow rocks, and formerly regarded as the base of the Old Red Sandstone, are now grouped with the Silurian strata. They have yielded a fauna consisting of ostracods, phyllocarid crustaceans, eurypterids, and fishes ; some of the fishes being identical with those in the underlying Ludlow rocks. The various subdivisions adopted by the Geological Survey are given in the following table[1] :

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[1] *Memoir of the Geological Survey*, "The Silurian Rocks of Scotland," p. 568.

SUB-DIVISION OF THE UPPER SILURIAN ROCKS.

Lower Old Red Sandstone.	*Volcanic Series.*	3. Andesites and tuffs (volcanic zone).
		2. Chocolate-coloured sandstones with *Cephalaspis Lyelli.*
		1. Conglomerate with greywacke pebbles.

Unconformability in the Pentland Hills and in Ayrshire; apparent conformability in Lanarkshire.

Upper Silurian.	*Downtonian.*	11. Chocolate-coloured sandstones—1200 feet in Lesmahagow inlier.
		10. Conglomerate with large pebbles of quartzite—100 feet in Lesmahagow inlier.
		9. Green and red mudstones, with bands of grey shale and greywacke, containing seams with fishes and crustaceans—100 feet in Lesmahagow inlier.
		8. Red and yellow false-bedded sandstones and red mudstones—1300 feet in Lesmahagow inlier.
		7. Conglomerate of local occurrence, with small pebbles of Arenig volcanic rocks, radiolarian cherts, etc., resting conformably on Ludlow shales—88 to 150 feet in the Hagshaw Hills anticline.
	Ludlow.	6. Green flaggy and sandy greywackes, with partings of grey and red mudstone—about 130 feet.
		5. Blue, grey, and green shales with sandy mudstones and greywackes, occasionally weathering with a rusty colour—200 feet (*Trochus* beds).
		4. Hard blue and grey flaggy shales and mudstones with occasional bands of calcareous nodules—350 feet (*Pterygotus* beds).
		3. Hard grey flagstones and bands of hard greywacke, with bands and zones of dark fissile calcareous flaggy shales, weathering rusty brown—500 feet (*Ceratiocaris* beds and Ludlow fish-band).
		2. Grey, blue, and olive shales, with occasional greywacke bands—300 feet.
	Wenlock.	1. Hard bands of greywacke in the shale partings—1300 feet.

Two lists of fossils are appended, one from the Wenlock and Ludlow rocks and the second from the Downtonian strata.

Fossils from the Wenlock-Ludlow Inliers of Lesmahagow, the Hagshaw Hills, and Carmichael Burn, Lanarkshire and Ayrshire

Hydrozoa.	
Monograptus vomerinus, *Nich.*	Hagshaws.
M. sp.	Carmichael Burn.
Actinozoa.	
Alveolites repens, *Fougt.*	
Favosites asper, *d'Orb.*	Hagshaws.
Lindströmia sp.	Hagshaws.
Crinoidea.	
Crinoid stems.	Hagshaws.
Annelida.	
Cornulites sp.	Hagshaws.
Spirorbis Lewisi, *Sow.*	Waterhead, L.
S. sp.	Logan Water, L.
Ostracoda.	
Beyrichia (Entomis) impendens, *J.*	Hagshaws.
B. Kloedeni, *M'Coy.*	Logan Water, L., H., C.
B. Kloedeni, var. **torosa**, *J.*	Logan Water, L.
B. (Entomis) tuberosa, *J.*	Hagshaws.
Entomis sp.	Hagshaws.
Phyllocarida.	
Calyptocaris striata, *Eth. Jnr.*	Carmichael Burn.
Ceratiocaris angusta, *J. and Woodw.*	Logan Water, L.
C. laxa, *J. and Woodw.*	Shank's Castle, L.
C. longa, *Woodw. and Jones.*	Shank's Castle, L.
C. Murchisoni, *M'Coy.*	Shank's Castle, L.
C. papilio, *Salt.*	Logan Water, L., H.
C. patula, *Jones and Woodw.*	Logan Water, L.
C. robusta, *Salt.*	Linn Burn, L.
C. stygia, *Salt.*	Logan Water, L.
C. tyrannus, *Salt.*	Logan Water, L.
C. sp.	Shank's Castle, L.
Trilobita.	
Calymene Blumenbachi, *Brong.*	Hagshaws.
Encrinurus sp.	Hagshaws.
Illaenus sp.	Hagshaws.
Phacops sp.	Hagshaws.
Proetus Stokesi, *Murch.*	Hagshaws.
Xiphosura.	
Neolimulus falcatus, *Woodw.*	Dunside, L
Eurypterida.	
Eurypterus lanceolatus, *Salt.*	Dunside, L.
E. obesus, *Woodw.*	Dunside, L.
E. scorpioides, *Woodw.*	Dunside, L.
Pterygotus bilobus, *Salt.*	Dunside, L.
P. bilobus, var. **accidens**, *Woodw.*	Dunside, L.
P. bilobus, var. **inornatus**, *Woodw.*	Dunside, L.
P. bilobus, var. **perornatus**, *Salt.*	Dunside, L.
P. bilobus, var. **raniceps**, *Woodw.*	Dunside, L.

Slimonia acuminata, *Salt.*	Logan Water, L.H.
Stylonurus Logani, *Woodw.*	Dunside, L.

ARACHNIDA.

Palaeophonus caledonicus, *Hunter.*	Logan House, L.

MYRIAPODA.

Archidesmus loganensis, *Peach.*	Logan House, L.
A. sp.	Shank's Castle, L.

POLYZOA.

Ceriopora sp.	Hagshaws.

BRACHIOPODA.

Athyris (Glassia) compressa, *Sow.*	Hagshaws.
Lingula cornea.	Blackberry Burn, L.
L. Lewisi.	Logan Water, L.
L. minima, *Sow.*	Logan Water, L.
Orthis Bouchardi, *Dav.*	Hagshaws.
O. (Dalmanella) elegantula, *Dalm.*	Hagshaws.
O. polygramma, *Sow.*	Hagshaws.
O. sp.	Nutberry Hill, L.
Rhynchonella sp.	Hagshaws.
Strophomena (Leptaena) rhomboidalis, *Wilck.*	Hagshaws.

LAMELLIBRANCHIATA.

Anadontopsis bulla, *M'Coy.*	Logan Water, L.
A. lucina, *Salt.*	Logan Water, L.
Ctenodonta obesa, *Salt.*	Logan Water, L.
C. sp.	Hagshaws.
Goniophora cymbaeformis, *Sow.*	Waterhead, L.
Modiolopsis complanata, *Sow.*	Waterhead, L.
M. Nilssoni, *His.*	Logan Water, Waterhead, L.
Mytilus mytilimeris, *Conr.*	Logan Water, L.
Orthonota amygdalina, *Sow.*	Logan Water, L.
O. impressa, *Sow.*	Logan Water, Waterhead, L.
O. rotundata, *Sow.*	Waterhead, L.
O. solenoides, *Sow.*	Logan Water, Waterhead, L.
O. sp.	Logan Water, L., H.
Pterinea pleuroptera, *Conr.*	Logan Water, L.
P. retroflexa, *Wahl.*	Logan Water, L.
P. retroflexa, var. **naviformis,** *Conr.*	Logan Water, L.

GASTEROPODA.

Holopella obsoleta, *Sow.*	Logan Water, L.
Murchisonia sp.	Nutberry Hill, L.
Platyschisma (Trochus) helicites, *Sow.*	Logan Water, L.

PTEROPODA (?).

Theca (Hyolithes) Forbesi, *Sharpe.*	Logan Water, L.
T. sp.	

CEPHALOPODA.

Orthoceras angulatum, *Wahl.*	Hagshaws.
O. dimidiatum, *Sow.*	Carmichael Burn.
O. gracile, *Portl.*	Hagshaws.

Orthoceras MacLareni, *Salt.*	Podowrin, H., L.
O. sp.	Hagshaws.

PISCES.

Birkenia elegans, *Traq.*	Shanks' Castle, L.
Thelodus planus, *Traq.*	Logan House, L.
T. scoticus, *Traq.*	Shanks' Cas., Logan House, Linn Burn, L.
Fish remains indt.	Logan House, L.

INCERTAE SEDIS.

Dictyocaris Ramsayi, *Salt.*	Shanks' Cas., Logan Water, L., H.
D Slimoni, *Salt.*	Blackberry Burn, L.

FOSSILS FROM THE DOWNTONIAN ROCKS OF THE LESMAHAGOW AND HAGSHAW HILLS AREAS.

Pachytheca sp.	Seggholm, Dippal, L.; Smithy Burn, H.
Parka sp.	Dippal. L.
P. sp. nov.	Dippal, L.
Sponge.	Seggholm, L.; Monk's Water, Smithy Burn, H.
Spirorbis sp.	Smithy Burn, H.
Beyrichia sp.	Birkenhead Burn, L.
Ceratiocaris laxa, *Jones & Woodw.*	Seggholm, L.
C. sp.	Birkenhead Burn, Dippal, L.
Eurypterus dolicoschelus, *Laurie.*	Seggholm, Dippal, L.; Smithy Burn, H.
E. sp.	Birkenhead Burn, L.
E. small sp.	Monk's Water, H.
Pterygotus bilobus, *Salt.*	Birkenhead Burn, L.
Slimonia acuminata, *Salt.*	Birkenhead Burn, L.
Stylonurus ornatus, *Laurie.*	Seggholm, L.
S. sp.	Birkenhead Burn, L.
Scorpion, fragment.	Monk's Water, H.
Myriapod.	Seggholm, L.
Glauconome disticha, *Goldf.*	Smithy Burn, H.
Ateleaspis tessellata, *Traq.*	Birkenhead Burn, Seggholm, L.; Smithy Burn, H.
Birkenia elegans, *Traq.*	Birkenhead Burn, Seggholm, Dippal, L.; Monk's Water, H.
Lanarkia horrida, *Traq.*	Birkenhead Burn, Seggholm, Dippal, L.; Monk's Water, H.
L. spinosa, *Traq.*	Birkenhead Burn, Seggholm, Dippal, L.; Monk's Water, H.
L. spinulosa, *Traq.*	Birkenhead Burn, Seggholm, Dippal, L.; Monk's Water, H.
Lasanius armatus, *Traq.*	Seggholm, L.
L. problematicus, *Traq.*	Birkenhead Burn, Seggholm, Monk's Water, Smithy Burn, H.
Thelodus scoticus, *Traq.*	Birkenhead Burn, Dippal, Seggholm, L.; Monk's Water, H.

INCERTAE SEDIS.

Dictyocaris sp.	L., H., C.
Chain of discs (=? sponge).	L., H.

THE TRILOBITES OF THE SILURIAN ROCKS OF SOUTHWEST SCOTLAND.

BY B. N. PEACH, F.R.S.

THE area under consideration is one in which there is an almost unbroken succession of rocks recording continuous deposition from Lower Arenig up to the close of Downtonian time—in fact nearly the whole of the Silurian period. During this prodigious lapse of time trilobites became the most prominent marine arthropods, they culminated in the Caradoc period, waned during Upper Silurian and Devonian time, while their last lingering remains finally disappeared within the Carboniferous period. As will be seen in the sequel the trilobite remains found in the Silurian rocks of the area, and more especially of the Girvan region, strongly bear out this conclusion.

LOWER SILURIAN.

During the deposition of the Arenig and Lower Llandeilo rocks of the area, which appear to have accumulated in an open sea free from land-borne sediment during pauses of volcanic activity, the conditions appear to have been so unfavourable to trilobite life that not a vestige of their remains has been recorded from rocks of these horizons. Towards the close of Upper Llandeilo time, however, when earth-movements had reared these pelagic strata above the surface over a great part of the area, trilobites appeared in profusion among the denizens of the shore, and their remains are numerous and well-preserved in the rocks representing the finer sediments derived from the newly emerged land. In the Girvan district the chief horizons in which they occur, beginning at the lowest strata and working upwards, are as follows:

The Stinchar limestone, proved by graptolite evidence to be near the top of the Upper Llandeilo rocks, occurs between the massive Kirkland and Benan conglomerates, and, together with its associated mudstones probably representing a pause in the uplift, has yielded 18 species belonging to 14 genera, the forms being of Caradoc facies as shown by R. Etheridge, Jnr.[1]

The next horizon is that of the Balclatchie mudstones overlying the great Benan conglomerate. From the graptolites yielded by the associated beds, which are those of the intermediate zone between the Glenkiln and Hartfell subdivisions, these beds must lie somewhere near the base of the Caradoc rocks of the region. These fine green mudstones have been looked upon by some observers as volcanic tuffs, but, like the Benan conglomerate itself, they are evidently only the ordinary detritus from the rocks of the ridged up Arenig volcanic group. They are exposed at Dow Hill and Ardmillan Braes to the south of Girvan as well as at the typical locality of Balclatchie. The mudstones have yielded the most abundant and best preserved remains of trilobites obtained from the Girvan region, belonging to 31 species falling under 18 genera, the facies being on the whole similar to that of the forms obtained from the Stinchar limestone.

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[1] "A Monograph of the Silurian Fossils of the Girvan District in Ayrshire," vol. i. By H. A. Nicholson and R. Etheridge, Jnr., 1880.

A third horizon from which trilobites have been obtained is of Middle Caradoc age, the beds being found at Whitehouse Bay and Shalloch Mill on the coast south of Girvan, where they consist of calcareous shales. These have yielded a special group of forms among which are *Agnostus perrugatus*, *Bohemilla sp.*, *Cyclopyge armata*, *C. rediviva*, *Dindymene Cordai*, and *Dionide Lapworthi*.

The next horizon lies at or near the top of the Caradoc subdivision and comprises the highest beds of the Lower Silurian series in Girvan. They are the well-known mudstones of Drummuck, almost identical in character with those of Balclatchie, and the prolific "Starfish Bed" of Threave, both the localities being in the inlier of Silurian rocks north of the Girvan valley. From these beds 16 species belonging to 12 genera have been obtained. Among these occur *Agnostus agnostiformis* and *Remopleurides Colbii*, the last surviving remains of the two great Cambrian families of the Agnostidae and Olenidae respectively, no member of which is known to pass up into Upper Silurian rocks. The Lower Silurian family of Trinucleidae is represented by *Trinucleus seticornis* and its variety *T. Bucklandi*, typical Upper Bala forms, and *Ampyx rostratus*, and *Dionide Lapworthi*, being only known in the Girvan region from the Whitehouse horizon. This is also the last appearance of any member of the family.

The other genera which occur in the Lower Silurian rocks of Girvan and the southwest of Scotland, but which do not pass up into the Upper Silurian horizons, are as follows: *Asaphus*, *Ogygia*, *Cyclopyge* (*Aeglina*), *Stygina*, *Bronteopsis*, *Barrandia*, *Salteria*, *Bohemilla*, *Deiphon*, *Sphaerexochus*, *Cybele*, and *Dindymene*.

Outside the Girvan area the only other Lower Silurian rocks that have yielded trilobite remains are those of Duntercleugh and Snar Water near Leadhills, Wallace's Cast on the Wandel Water near Abington, and Culter Water and Kilbucho further to the east. The rocks in which they occur are all of similar type, conglomerates and coarse grits with calcareous nodules, associated with calcareous shales. That the rocks at the different localities are on one horizon is shown by the trilobite remains which they have yielded, numbering 11 species belonging to 8 genera, which are all of Lower Caradoc facies and very similar to those from the Balclatchie mudstones of Girvan. The horizon is proved to be probably that of the *Dicranograptus Clingani* sub-zone of the Hartfell group from the relation of the conglomerates to the black shales of the neighbourhood where they occur.

UPPER SILURIAN.

Returning to the Girvan area, the lowest members of the Llandovery rocks, viz., the shelly mudstones of Mulloch Hill and Rough Neuk, localities to the northeast of Girvan, have yielded the remains of 9 genera and 12 species of trilobites. The next horizon is found at Woodland Point, south of Girvan, in beds belonging to the Monograptus gregarius zone of the Birkhill group. These rocks have yielded 14 species belonging to 9 genera, many of the forms being common with those from the Mulloch Hill beds and the horizon next to be considered. The next horizon is that of the Rastrites maximus sub-zone, the highest of the Birkhill group and the top of the Llandovery rocks. The beds are exposed at Penkill and in the Bargany Pond Burn to the south of the Girvan Water between Girvan and Dailly. The beds there have yielded 16 species belonging to 9 genera. A few trilobites have been obtained from a somewhat higher horizon, Tarannon, in Penkill Burn.

From the rocks of Blair and Knockgardner between Girvan and Straiton, which represent a still higher horizon, either at the top of the Tarannons or the base of the Wenlock series, the following species have been obtained: *Calymene Blumenbachi*, *Encrinurus punctatus* and its variety *E. arenaceus*, *Phacops Downingiae*, *P. Stokesi*, and *Proetus Stokesi.*

The genera of trilobites found in the Upper Silurian rocks of Girvan, all of which made their appearance in Lower Silurian times and occur in those rocks at Girvan, are, *Acidaspis*, *Bronteus*, *Calymene*, *Cheirurus*, *Encrinurus*, *Harpes*, *Illaenus* with its sub-genera *Dysplanus* and *Bumastus*, *Lichas*, *Phacops*, *Proetus*, and *Staurocephalus.* The genera *Homalonotus* and *Phillipsia* occur in the Lower Silurian rocks of the area, the former at Duntercleuch, and the latter represented by *Phillipsia parabola* at Threave. Though these genera are not represented in the Upper Silurian rocks of Girvan they pass up elsewhere, the former to the Devonian, and the latter as far as the Carboniferous. Beyond the Girvan area the only band of Upper Silurian rocks that has yielded trilobites is found among the Wenlock-Ludlow rocks of the Hagshaw Hill inlier of Lanarkshire. The locality is near High Broomerside on the Podowrin Burn, a tributary of the Douglas Water, and the strata consist of shales. These have yielded to Mr. Macconochie *Calymene Blumenbachi*, *Encrinurus* sp., *Illaenus* sp., *Phacops* sp., and *Proetus Stokesi*, a group almost identical with that from Blair and Straiton in the Girvan region.

It will be seen from the above that the distribution of the trilobite remains is similar to that which obtains elsewhere in Britain and Europe generally. The whole facies is European, even down to the forms that occur in the Stinchar limestone, though the corals of that zone were shown by Nicholson to be of American facies,[1] and the peculiar American gasteropod genera *Maclurea* and *Ophileta* which occur in it have only been found elsewhere in Europe in the Durness limestone. The forms have a nearer affinity with those of Bohemia than those of Scandinavia and Russia, and it is evident that they belong to the same great geographical and biological province. The constant association of trilobite remains with mudstones and shales in the area under consideration seems to point to muddy sea-bottoms not far from shore having been their favourite habitat, a fortunate circumstance, since it favoured the preservation of their moults and their dead bodies for our study.

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[1] *Op. cit.*, p. 95.

THE CRUSTACEA OF THE SILURIAN ROCKS OF SOUTHWEST SCOTLAND.

BY B. N. PEACH, F.R.S.

PHYLLOCARIDA.

THE phyllocarids are represented by *Caryocaris Wrighti* in the Arenig rocks of Balcreuchan Port and Bennane Head near Ballantrae, and of Ravensgill near Abington, the form being also found elsewhere in rocks of this horizon. The Caradoc rocks of Girvan have yielded two genera and species, viz. *Pinnocaris Lapworthi*, which occurs in the Balclatchie sandstones at their base, and *Solenocaris solenoides* in the Drummuck and Threave beds near their upper limit. In the Tarannon rocks of Blackwood Head, near Dailly, *Discinocaris gigas* has been found. This form occurs at Moffat in the Birkhill shales at a somewhat lower horizon along with *D. browniana* and *Peltocaris aptychoides*. These two latter forms have been recorded from the Birkhill shales, outcrops between Portpatrick and the Mull of Galloway, and reappear along with these shales in Ireland on the opposite shore of the Channel at Coalpit Bay, near Donaghadee. A form doubtfully referred to *Peltocaris* has been recorded by Mrs. Gray from Penkill in the Girvan area.

The genus *Aptychopsis* has not yet been recorded from the Girvan area, nor from the Wenlock rocks of the northwest margin of the southern uplands, but two species have been recorded from the Tarannon and Wenlock rocks of Burrow Head to the south of Wigtown. All the forms above enumerated seem to have associated with graptolites, as they are mostly found embedded in graptolite-shales, and seem like the graptolites to have flourished best at or near the limit of sedimentation.

The genus *Ceratiocaris* is the prevailing phyllocarid form in the Wenlock-Ludlow rocks of Lesmahagow and the Hagshaw Hills, no fewer than nine species having been recorded from these beds. They occur in such numbers in certain bands that they have given the name to a very important sub-zone of the Ludlow rocks of the Lesmahagow inlier, viz. that from which the Ludlow fish- and scorpion-remains have been obtained. It is from these beds that the specimen showing abdominal appendages described by R. Etheridge, Jnr.,[1] and a considerable amount of the material which is figured by Jones and Woodward in their monograph[2] was obtained.

The species of this genus seem to have frequented the muddy bottoms where slow deposition was going on, for their remains are most numerous in certain finely-laminated calcareous beds which are comparatively free from the remains of lamellibranchs and gasteropods which crowd many of the less finely laminated beds of the Lesmahagow inlier. In the

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[1] *Memoirs Geol. Surv. Scot.* "Explanation" of Sheet 23, p. 93.

[2] *Palaeont. Soc. Monograph on* "British Palaeozoic Phyllocarida," part i.

Wenlock rocks of the southeast border of Scotland their remains are often found associated with such graptolites as *Monograptus priodon*, *M. Flemingii*, and *Retiolites Geinitzianus*, and with *Orthoceratites*, in thinly-laminated dark shales which weather into layers as fine as writing paper.

In their Monograph on the British Fossil Phyllocarida Professor Jones and Dr. Woodward make a new genus, *Calyptocaris*,[1] to include the form recorded by R. Etheridge, Jnr., as *Dithyrocaris* (?) *striata*,[2] which was obtained by the Geological Survey from Carmichael Burn near Carmichael Manse, to the north of Tinto in Lanarkshire. In 1873, at the time of the publication of the "Explanation" of Sheet 23, these beds were considered by the Geological Survey to belong to the Lower Old Red Sandstone formation,[3] but their subsequent work has shown them to be the uppermost zones of the Ludlow shales, which, together with the Downtonian rocks, make their appearance upon the back of a denuded isoclinal fold in the midst of Lower Old Red strata.[4]

OSTRACODA.

In the Girvan area ostracoda have been found on several horizons. The lowest horizon is that of the Stinchar limestone which at Aldons lime-works near Pinmore has yielded five species of the genus *Cythere* and one species of *Primitia* which Professor Rupert Jones considers to be of eminently Lower Silurian type.

From the Middle Caradoc shales of Whitehouse Bay Mrs. Gray has obtained the following forms—*Aparchites leperditioides*, *A. subovatus*, *Beyrichia impar*, *Cypridina Grayae*, *Primitia elongata*, var. *nuda*, *P. girvanensis*, *P. Grayae*, *P. Krausei*, *P. mundula*, var. *fimbriata*, *P. mundula*, var. *Kloedeniana*, *P. ulrichiana*, and *Sulcuna praeurrens*.

In the uppermost Caradoc rocks of Threave is the first appearance of the genus *Beyrichia*, represented by *B. comma*, and the common Upper Silurian form *B. Kloedeni*.

In the Upper Silurian rocks of Girvan and Straiton, in the Bargany Pond Burn, in shales at the top of the Llandovery Rocks, a variety of *Beyrichia Kloedeni* occurs, and the Wenlock rocks of Straiton have yielded the familiar forms *Beyrichia Kloedeni*, *B.* (*Entomis*) *impendens*, and *Entomis globulosa*. In the main it would appear that these early entomostraca seem to have frequented the same kind of sea-bottom as that sought out by the trilobites, as their remains are obtained from the same localities and the same beds.

In areas outside that of Girvan entomostraca swarm in some of the Wenlock-Ludlow beds of the Lesmahagow and Hagshaw inliers of Lanarkshire, but they are restricted to one or two species, *Beyrichia Kloedeni* and one of its varieties being the principal forms. A species of *Entomis* also occurs. A species of *Beyrichia* is rare in the Downtonian fish-beds.

CIRRIPEDIA.

Two species of *Turrilepas* have been found in the Lower Silurian rocks of Girvan at Balclatchie, Whitehouse, and Drummuck, and an unnamed species from the Newlands beds in the Llandovery rocks.

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[1] *Palaeontolographical Soc.*, vol. liii., p. 183, pl. xviii., fig. 7, 1899.
[2] *Memoirs Geol. Surv. Scot.* "Explanation" to Sheet 23, pp. 57 and 100.
[3] *Ibid.*, p. 14, par. 24.
[4] *Mem. Geol. Surv. U.K.*, vol. i., pp. 586-588.

THE ARTHROPODA FROM THE SILURIAN ROCKS OF SOUTHWEST SCOTLAND.

BY B. N. PEACH, F.R.S.

CIRRIPEDIA.

Turrilepas Peachi, *Nich. and Eth.*—Caradoc: Girvan.
T. scotica, *N. and E.*—Caradoc: Girvan.
T. Wrighti, *Woodw.*—Caradoc: Girvan.
T. sp.—Caradoc and Llandovery: Girvan.
T. sp.

OSTRACODA.

Aparchites leperditioides, *J.*—Caradoc: Girvan.
A. subovatus, *J.*—Caradoc: Girvan.
Beyrichia comma, *J.*—Caradoc: Girvan.
B. impar, *J.*—Caradoc: Girvan.
B. (Entomis) impendens, *J.*—Ludlow: Hagshaw Hills.
B. Kloedeni, *M'Coy.*—Caradoc to Ludlow: Girvan, Lesmahagow, Hagshaw Hills, Carmichael Burn.
B. Kloedeni, var. **infecta,** *J.*—Caradoc: Girvan.
B. Kloedeni, var. **scotica,** *J. and Holl.*—Llandovery: Girvan.
B. Kloedeni, var. **torosa,** *J.*—Ludlow: Lesmahagow.
B. (Entomis) tuberosa.—Ludlow: Hagshaw Hills.
B. sp.—Downtonian: Lesmahagow.
Cythere aldensis, *M'Coy.*—Llandeilo: Girvan.
C. aldensis, var. **major,** *J.*—Llandeilo: Girvan.
C. Grayana, *J.*—Llandeilo: Girvan.
C. Wrightiana, *J. and Holl.*—Llandeilo: Girvan.
C. sp.—Llandeilo and Llandovery: Girvan.
Cypridina Grayae, *J.*—Caradoc: Girvan.
Entomis globulosa, *J.*—Wenlock: Straiton.
E. sp.—Ludlow: Hagshaw Hills.
Primitia Barrandiana, *J.*—Caradoc: Girvan.
P. elongata, var. **nuda,** *J.*—Caradoc: Girvan.
P. girvanensis, *J.*—Caradoc: Girvan.
P. Grayae, *J.*—Caradoc: Girvan.
P. Krausei, *J.*—Caradoc: Girvan.
P. mundula, var. **fimbriata,** *J.*—Caradoc: Girvan.
P. mundula, var. **Kloedeniana,** *J.*—Caradoc: Girvan.
P. ulrichiana, *J.*—Caradoc: Girvan.

PHYLLOCARIDA.

Caryocaris Wrighti, *Salt.*—Arenig: Girvan, Abington district.
Ceratiocaris angusta, *J. and Woodw.*—Ludlow: Lesmahagow.

Ceratiocaris laxa, *J. and W.*—Ludlow : Lesmahagow.
C. **longa**, *W. and J.*—Ludlow : Lesmahagow.
C. **Murchisoni**, *M'Coy.*—Ludlow : Lesmahagow.
C. **papilio**, *Salt.*—Ludlow : Lesmahagow.
C. **patula**, *J. and W.*—Ludlow : Lesmahagow.
C. **robusta**, *Salt.*—Ludlow : Lesmahagow.
C. **stygia**, *Salt.*—Ludlow : Lesmahagow.
C. **tyrannus**, *Salt.*—Ludlow : Lesmahagow.
C. **sp.**—Ludlow : Lesmahagow.
Discinocaris gigas, *W.*—Tarannon : Girvan.
Calyptocaris striata, *Eth. Jr.*—Ludlow : Carmichael Burn, Lanarkshire.
Pinnocaris Lapworthi, *Eth. Jr.*—Caradoc : Girvan.
Solenocaris solenoides, *Y.*—Caradoc : Girvan.

TRILOBITA.

Acidaspis bispinosa, *M'Coy.*—Llandovery : Girvan.
A. **Brighti**, *Murch.*—Llandovery : Girvan.
A. **Grayae**, *Eth. Jr.*—Caradoc : Girvan.
A. **hystrix**, *Eth. Jr.*—Caradoc : Girvan.
A. **Lalage**, *Wyv.-Thom.*—Caradoc : Girvan.
A. **sp.**—Llandovery : Girvan.
Agnostus agnostiformis, *M'Coy.*—Caradoc : Girvan.
A. **perrugatus**, *Barr.*—Caradoc : Girvan.
Ampyx Hornei, *E. and N.*—Llandeilo and Caradoc : Girvan.
A. **Maccallumi**, *Salt.*—Caradoc : Girvan.
A. **mammillatus**, *Sars.*—Caradoc : Girvan.
A. **nasutus**, *Dalm.*—Caradoc : Girvan.
A. **nudus**, *Murch.*—Caradoc : Girvan.
A. **rostratus**, *Sars.*—Caradoc : Girvan.
Asaphus (Isotelus) gigas, *De Kay.*—Upper Llandeilo and Lower Caradoc : Girvan.
A. **marginatus**, *Portl.*—U. Caradoc : Girvan.
A. **rectifrons**, *Portl.*—U. Llandeilo and L. Caradoc : Girvan.
Barrandia sp.—L. Caradoc : Girvan.
Bohemilla sp.—U. Caradoc : Girvan.
Bronteopsis scotica, *Salt.*—L. Caradoc : Girvan.
Bronteus Andersoni, *E. and N.*—U. Llandeilo to Llandovery : Girvan.
B. **hibernicus**, *Portl.*—U. Caradoc : Girvan.
Calymene Blumenbachi, *Brong.*—U. Llandeilo to Wenlock : Girvan and Hagshaw Hills.
C. **tuberculosa**, *Salt.*—U. Caradoc : Girvan.
C. **sp.**—L. Caradoc : Abington district.
Cheirurus bimucronatus, *Murch.*—U. Llandeilo to Tarannon : Girvan.
C. **clavifrons**, *Dalm.*—L. and U. Caradoc : Girvan and Abington.
C. **gelasinosus**, *Portl.*—U. Llandeilo and L. Caradoc : Girvan.
C. **Sedgwicki**, *M'Coy.*—L. Caradoc : Girvan.
C. **trispinosa**, *Young.*—Llandovery : Girvan.
C. **sp.**—L. Caradoc : Girvan.
Cybele rugosa, *Portl.*—Caradoc : Girvan.
C. **verrucosa**, *Dalm.*—Caradoc : Girvan.
Cyclopyge armata, *Barr.*—Caradoc : Girvan.
C. **rediviva**, *Barr.*—Caradoc : Girvan.
Deiphon Forbesi, *Barr.*—L. Caradoc : Girvan.
Dindymene Cordai, *E. and N.*—Caradoc : Girvan.
Dionide Lapworthi, *E. and N.*—Caradoc : Girvan.
D. **sp.**—Caradoc : Girvan.

Encrinurus punctatus, *Brün.*—Llandovery to Wenlock : Girvan, Abington district, Straiton.
E. punctatus, var. **arenosus**, *Salt.*—U. Llandeilo to Wenlock : Girvan, Abington district, Straiton.
E. punctatus, var. **calcareus**, *Salt.*—U. Llandeilo to Llandovery : Girvan.
Harpes sp.—U. Llandeilo to Tarannon : Girvan.
Homalonotus sp.—L. Caradoc : Abington district.
Illaenus (Dysplanus) aemulus, *Salt.*—Llandovery : Abington district.
I. (Bumastus) Barriensis, *Murch.*—Llandovery : Abington district.
I. (B.) Bowmani, *Salt.*—U. Llandeilo to L. Caradoc : Abington district.
I. (B.) Maccallumi, *Salt.*—U. Caradoc : Girvan and Abington district.
I. latus (?), *M'Coy.*—U. Llandeilo and L. Caradoc : Girvan and Abington district.
I. Murchisoni, *Salt.*—Llandovery : Girvan and Abington district.
I. nexilis, *Salt.*—U. Caradoc to Llandovery : Girvan and Abington district.
I. Rosenbergi, *Eichw.*—Llandovery : Girvan.
I. Thomsoni, *Salt.*—Llandovery : Girvan.
I. sp.—Caradoc and Llandovery : Girvan.
Lichas ambiguus, *Barr.*—Llandovery : Girvan.
L. Barrandei, *Flet.*—Llandovery : Girvan.
L. Geikiei, *E. and N.*—U. Caradoc : Girvan.
L. Grayi, *Flet.*—L. Caradoc : Girvan.
L. hibernicus, *Portl.*—U. Llandeilo and L. Caradoc : Girvan.
L. laxatus, *M'Coy.*—U. Caradoc : Girvan.
L. palmatus, *Barr.*—Llandovery : Girvan.
L. sp.—L. Caradoc to Llandovery ; Girvan.
Ogygia, **sp.**—Caradoc : Leadhills.
Phacops alifrons, *Salt.*—L. Caradoc : Abington district.
P. (Acaste) Brongniarti, *Portl.*—U. Llandeilo to U. Caradoc : Girvan and Abington.
P. Downingiae, *Murch.*—Llandovery to Wenlock : Girvan and Straiton.
P. Stokesi, *M. Edw.* —Wenlock : Hagshaw Hills.
P. sp.—L. Caradoc, Ludlow : Abington, Hagshaw Hills.
Phillipsia parabola, *Barr.*—U. Caradoc : Girvan.
Proetus girvanensis, *E. and N.*—L. and U. Caradoc : Girvan.
P. latifrons, *M'Coy.*—U. Caradoc : Girvan.
P. procerus, *E. and N.*—U. Caradoc : Girvan.
P. Stokesi, *Murch.*—Wenlock : Straiton.
Remopleurides Barrandei, *E. and N.*—L. Caradoc : Girvan.
R. Colbii, *Portl.*—U. Llandeilo and L. Caradoc : Girvan and Abington.
R. dorsospinifer, *Portl.*—L. Caradoc : Girvan.
R. laterispinifer, *Portl.*—U. Landeilo and L. Caradoc : Girvan and Abington.
Salteria primaeva, *Wyv.-Thom.*—L. Caradoc : Girvan.
Sphaerexochus mirus, *Beyr.*—U. Llandeilo to L. Caradoc : Girvan.
Staurocephalus globiceps, *Portl.*—L. Caradoc to Llandovery : Girvan.
S. unicus, *Wyv.-Thom.*—L. Caradoc to Llandovery : Girvan.
S. sp.—Llandovery : Girvan.
Stygina latifrons, *Portl.*—L. Caradoc : Girvan.
Trinucleus concentricus, *Eaton.*—L. Caradoc : Girvan.
T. Macconochiei, *E. and H.*—L. Caradoc : Girvan.
T. ornatus, *Stern.*—L. Caradoc : Girvan.
T. seticornis, *His.*—U. Caradoc : Girvan.
T. seticornis, var. **Bucklandi**, *Barr.*—U. Caradoc : Girvan.

XIPHOSURA.

Neolimulus falcatus, *Woodw.*—Ludlow : Lesmahagow.

EURYPTERIDA.

Eurypterus lanceolatus, *Salt.*—Ludlow : Lesmahagow.
E. obesus, *Woodw.*—Ludlow : Lesmahagow.
E. scorpioides, *Woodw.*—Ludlow : Lesmahagow.
E. dolicoschelus, *Laurie.*—Downtonian : Lesmahagow.
E. sp.—Hagshaw Hills.
Pterygotus bilobus, *Salt.*—Ludlow and Downtonian : Hagshaw Hills.
P. bilobus, var. **accidens**, *Woodw.*—Ludlow : Hagshaw Hills.
P. bilobus, var. **inornatus**, *Woodw.*—Ludlow : Hagshaw Hills.
P. bilobus, var. **perornatus**, *Salt.*—Ludlow : Hagshaw Hills.
P. raniceps, *Woodw.*—Ludlow : Hagshaw Hills.
Slimonia acuminata, *Salt.*—Ludlow and Downtonian : Hagshaw Hills.
Stylonurus Logani, *Woodw.*—Ludlow : Hagshaw Hills.
S. ornatus, *Laurie.*—Downtonian : Hagshaw Hills.

ARACHNIDA.

Palaeophonus caledonicus, *Hunter.*—Ludlow : Lesmahagow.
P. sp.—Downtonian : Hagshaw Hills.

MYRIAPODA.

Archidesmus loganensis, *Peach.*—Ludlow : Lesmahagow.
A. sp.—Ludlow and Downtonian : Lesmahagow.

GRAPTOLITES.

By Professor C. Lapworth, F.R.S., Birmingham University.

The Silurian strata of the Basin of the Firth of Clyde contain some of the richest graptolite-bearing deposits in the world, and the Graptolites which they afford include examples of all the known families of this group of fossils.

Researches carried on in the region of the Southern Uplands of Scotland (a portion of which lies within the limits of the Basin of the Clyde) first demonstrated the reliability of Graptolites as "zone fossils" for unravelling the sequence of the British Lower Palaeozoic deposits: and within the last thirty years these fossils have been keenly studied by foreign geologists and palaeontologists in Scandinavia, France, Bohemia, Belgium, Canada, the United States, etc. In these countries, as in Britain, their first-rate importance as aids in working out the geology of the older stratified rocks has long been admitted and utilized. Geologists owe it to the Graptolites that they are now able to divide the Ordovician and Silurian strata into successive chronological "life zones" corresponding with those demonstrated by means of the Ammonites for the Jurassic sediments more than half a century ago, and to parallel satisfactorily the strata containing them in Britain with the equivalent deposits in Europe and America.

The region of the Southern Uplands of Scotland—of which the basin of the Upper Clyde forms a part—is the type region for these fossils in Britain from the stratigraphical point of view. The recent *Memoir* of the Geological Survey ("The Silurian Rocks of Britain," vol. i., 1899) gives an admirable and detailed account of the distribution of Graptolites in the southwest of Scotland, and of the geology of the Southern Uplands. To this work the reader is referred.

Graptolites are especially abundant in the Silurian rocks of the basin of the Upper Clyde at the localities of Wanlockhead and the Leadhills. Here they constitute the predominant fossils of the district, and are practically confined to certain black shale bands which run through the country along the strike of the beds. They are also present, in less abundance, however, in the Silurian strata of the coastal district of Girvan; but here they are often associated with crowds of other fossils—Brachiopods, Trilobites, Cephalopods, etc., and are more generally distributed throughout the entire succession.

In the Guide Book issued for the members of the British Association at its last meeting in Glasgow in 1876 ("Catalogue of Western Scottish Fossils," J. Armstrong, J. Young, and D. Robertson) four plates by the writer of figures of the more characteristic Scottish Graptolites were included. Figures of the common Scottish forms have also been published elsewhere. See for example the *Proceedings of the Belfast Naturalists' Field Club*, Appendix, 1876-1877, and the plates in the Survey *Memoir*, 1899, cited above.

The following Catalogue gives the names of the species of Graptolites hitherto recognised in the Silurian strata of the West of Scotland; and the appended Bibliography embraces the titles of those works and papers which deal with the description and illustration of these Scottish forms, or with their local or general geological distribution.

The localities for the various Graptolite species are arranged in the following order:

1. Girvan and Ballantrae district.
2. Currarie and Stinchar district.
3. Wanlockhead district of the Upper Clyde basin.

When the localities belong to different districts they are separated by a hyphen.

The letters N. and S. in brackets ( ) refer to the northern and southern portions of the long section in Penwhapple Glen, Girvan district.

The geological range of each species is indicated by the initial letter of the formation in which it occurs being placed after the name in heavy type.

A. = Arenig: **L.** = Lower Llandeilo: **G.** = Glenkiln: **H.** = Hartfell:
B. = Birkhill: **T.** = Tarannon: **W.** = Wenlock.

Fam. Monograptidae.

Rastrites distans, *Lapw.*—**T.** Penwhapple Glen (N.).
R. hybridus, *Lapw.*—**B.** Saugh Hill: Penwhapple Glen (N.).
R. maximus, *Carr.*—**B.** Penwhapple Glen (N.): Bargany Pond Burn.
R. peregrinus, *Barr.*—**B.** Baldrennan Burn: Penwhapple Glen (N.): Saugh Hill.
Monograptus argutus, *Lapw.*—**B.** Baldrennan Burn.
M. attenuatus, *Hopk.*—**B.** Penwhapple Glen (N.): Baldrennan Burn.
M. Becki, *Barr.*—**T.** Penwhapple Glen (N.).
M. concinnus, *Lapw.*—**B.** Penwhapple Glen (N.).
M. convolutus, *His.*—**B.** Penwhapple Glen (N.): Saugh Hill.
M. crassus, *Lapw.*—**B.** Penwhapple Glen (N.): Bargany Pond Burn.
M. crenularis, *Lapw.*—**B.** Baldrennan Burn.
M. cyphus, *Lapw.*—**B.** Saugh Hill: Shalloch Forge: Woodland Point.
M. exiguus, *Nich.*—**T.** Penwhapple Glen (N.).
M. fimbriatus, *Lapw.*—**B.** Baldrennan Burn.
M. Flemingi, *Salt.*—**W.** Lady Burn: Blair Quarry.
M. galaensis, *Lapw.*—**B., W.** Penwhapple Glen (N.).
M. gregarius, *Lapw.*—**B.** Baldrennan Burn: Penwhapple Glen (N.): Saugh Hill: Woodland Point.
M. intermedius, *Carr.*—**B.** Penwhapple Glen (N.).
M. jaculum, *Carr.*—**B.** Penwhapple Glen (N.): Bargany Pond Burn.
M. leptotheca, *Lapw.*—**B.** Baldrennan Burn: Penwhapple Glen (N.): Woodland Point: Saugh Hill: Shalloch Forge.
M. lobiferus, *M'Coy.*—**B.** Saugh Hill.
M. priodon, *Brown.*—**T. W.** Penwhapple Glen (N.).
M. riccartonensis, *Lapw.*—**W.** Blair Quarry.
M. runcinatus, *Lapw.*—**B.** Penwhapple Glen (N.).
M. Sedgwicki, *Portlock.*—**B.** Penwhapple Glen (N.): Saugh Hill.
M. tenuis, *Portlock.*—**B.** Glenwells Burn?: Baldrennan Burn: Penwhapple Glen (N.): Saugh Hill: Shalloch Forge: Woodland Point.
M. turriculatus, *Barr.*—**T.** Penwhapple Glen (N.): Bargany Pond Burn.
M. vomerinus, *Nich.*—**W.** Blair Quarry: Lady Burn.
Cyrtograptus Grayi, *Lapw.*—**T.** Penwhapple Glen (N.).

Fam. Leptograptidae.

Leptograptus flaccidus, *Hall.*—**H.** Shalloch Mill: Penwhapple Glen (S.): Byne Burn:—Hortin Gill.

Amphigraptus radiatus, *Lapw.*—**G.**, **H.** Castle Hill, Abington.

Pleurograptus linearis, *Carr.*—**H.** Shalloch Mill: Penwhapple Glen (S.): Byne Burn.

Coenograptus explanatus, *Lapw.*—**G.** Wandel Water.

C. gracilis, *Hall.*—**G.** Rough Gill: Rein Gill: Wandel Water: Castle Hill: Gair Gill: Hortin Gill: Wanlock Water: Duntercleuch Burn.

C. pertenuis, *Lapw.*—**G.**—Portandea:—Rein Gill: Wandel Water: Gair Gill: Hortin Gill: Glengaber Burn: Duntercleuch Burn.

C. surcularis, *Hall.*—**G.** Gair Gill: Wanlock Water.

Fam. Dicranograptidae.

Dicellograptus anceps, *Nich.*—**H.** Lady Burn.

D. complanatus, *Lapw.*—**H.** Shalloch Mill: Whitehouse Bay.

D. divaricatus, *Hall.*—**G.** Port Currarie:—Wandel Water: Key Gill: Gair Gill.

D. elegans, *Carr.*—**G.** Rein Gill: Castle Hill?

D. Forchammeri, *Geinitz.*—**H.** Penwhapple Glen: Dalamford: Ardmillan Shore:—Castle Hill.

D. Forchammeri, var. **flexuosus**, *Lapw.*—**G.**, **H.** Castle Hill.

D. intortus, *Lapw.*—**G.** Rein Gill: Wandel Water: Castle Hill.

D. moffatensis, *Carr.*—**G.**, **H.** Portandea:—Ardmillan Braes: Penwhapple Glen (S.):—Rein Gill: Wandel Water: Laggan Gill: Hortin Gill: Duntercleuch Burn, &c.

D. Morrisi, *Hopk.*—**H.** Whitehouse Bay: Shalloch Mill: Penwhapple Glen (S.): Byne Burn.

D. patulosus, *Lapw.*—**G.** Portandea:—Wandel Water: Laggan Gill: Hortin Gill: Wanlock Water: Glengaber Burn: Duntercleuch Burn, &c.

D. sextans, *Hall.*—**G.** Benan Burn:—Portandea: Port Currarie:—Rein Gill: Wandel Water: Castle Hill: Laggan Gill: Glengaber Burn: Duntercleuch Burn, &c.

Dicranograptus formosus, *Hopk.*—**G.** Rein Gill: Wandel Water: Castle Hill: Laggan Gill, &c.

D. Nicholsoni, *Hopk.*—**G.**, **H.** Pinmore:—Rough Gill: Rein Gill: Wandel Water: Glengonner Burn: Wanlock Water.

D. ramosus, *Hall.*—**G.**, **H.** Craighead: Laggan Gill: Ardmillan Shore: Penwhapple Glen (S.):—Rough Gill: Wandel Water: Glengonner Burn: Wanlock Water: Duntercleuch Burn, &c.

D. ramosus, var. **spinosus**, *Lapw.*—Pinmore:—Wandel Water.

D. rectus, *Hopk.*—**G.** Glengonner Burn.

D. tardiusculus, *Lapw.*—**G.**, **H.** Penwhapple Glen (S.): Ardmillan Braes: Balclatchie.

D. zic-zac, *Lapw.*—**G.** Rein Gill: Wandel Water.

D. zic-zac, var. **minimus**, *Lapw.*—**G.** Castle Hill: Wanlock Water: Duntercleuch Burn, &c.

Fam. Dichograptidae.

Didymograptus bifidus, *Hall.*—**A.** Bennane Head.

D. extensus, *Hall.*—**A.** Bennane Head.

D. serratulus, *Hall.*—**G.** Wandel Water: Birnock Burn.

D. superstes, *Lapw.*—**G.** Benan Burn:—Wandel Water: Wanlock Water: Glengaber Burn, &c.

Tetragraptus Bigsbyi, *Hall.*—**A.** Bennane Head: Pinbain Burn.

Tetragraptus bryonoides, *Hall.*—**A.** Bennane Head: Balcreuchan Port: Pinbain Burn.

T. fruticosus, *Hall.*—**A.** Bennane Head: Raven Gill.

T. Headi, *Hall.*—**A.** Balcreuchan Port.

T. quadribrachiatus, *Hall.*—**A.** Bennane Head: Pinbain Burn: Raven Gill.

Phyllograptus typus, *Hall.*—**A.** Bennane Head: Pinbain Burn.

Loganograptus Logani, *Hall.*—**G.** Hortin Gill.

Dichograptus multiplex, *Nich.*—**A.** Bennane Head.

D. octobrachiatus, *Hall.*—**A.** Bennane Head.

D. reticulatus, *Nich.*—**A.** Bennane Head.

Fam. Diplograptidae.

Diplograptus angustifolius, *Hall*, var. **euglyphus**, *Lapw.*—**G.** Benan Burn:—Rein Gill: Duntercleuch Burn: Wanlock Water, &c.

D. foliaceus, *Murch.*—**G.**, **H.** Portandea.

D. foliaceus, var. **vulgatus**, *Lapw.*—**G.** Craighead: Laggan Gill: Ardmillan Shore: Shalloch Mill: Penwhapple Glen (S.):—Wandel Burn: Glengaber Burn: Wanlock Water, &c.

D. foliaceus, var. **rugosus**, *Emm.*—**G.**, **H.** Benan Burn: Millenderdale: Craighead: Penwhapple Glen (S.): Laggan Gill: Ardmillan Shore: Dalamford.

D. modestus, *Lapw.*—**B.** Penwhapple Glen (N.): Saugh Hill: Shalloch Mill: Woodland Point.

D. perexcavatus, *Lapw.*—**G.** Rein Gill: Wandel Water: Coldchapel Burn: Castle Hill, &c.

D. quadrimucronatus, *Hall.*—**H.** Whitehouse Bay: Shalloch Mill: Penwhapple Glen (S.): Byne Burn.

D. socialis, *Lapw.*—**H.** Whitehouse Bay.

D. tamariscus, *Nich.*—**B.** Baldrennan Burn: Penwhapple Glen (N.): Saugh Hill.

D. truncatus, *Lapw.*—**H.** Whitehouse Bay: Penwhapple Glen (S.): Lady Burn.

Climacograptus bicornis, *Hall.*—**G.**, **H.** Benan Burn: Craighead: Laggan Gill: Ardmillan Shore: Penwhapple Glen (S.):—Wandel Burn: Rein Gill: Wanlock Water: Glengaber Burn, &c., &c.

C. bicornis, var. peltifer, *Lapw.*—**G.** Rein Gill: Coldchapel Burn: Wanlock Water, &c.

C. bicornis, var. **tridentatus**, *Lapw.*—**G.**, **H.** Wandel Water: Glengonner Burn: Wanlock Water, &c.

C. caudatus, *Lapw.*—**G.**, **H.** Ardmillan Shore: Penwhapple Glen (S.): Dalamford: Piedmont Glen: Duncan Gill: Castle Hill: Glengonner Burn, &c.

C. coelatus, *Lapw.*—**G.**, **H.** Penwhapple Glen (S.): Portandea: Currarie:—Wandel Burn: Wanlock Water.

C. normalis, *Lapw.*—**B.** Glenwells Burn: Baldrennan Burn: Penwhapple Glen (N.): Saugh Hill: Shalloch Forge: Woodland Point.

C. rectangularis, *M'Coy*—**B.** Woodland Point.

C. Scharenbergi, *Lapw.*—**G.**, **H.** Benan Burn: Millenderdale: Craighead: Laggan Gill: Penwhapple Glen (S.): Portandea:—Wanlock Water: Glengaber Burn, &c.

C. tubuliferus, *Lapw.*—**H.** Shalloch Mill: Penwhapple Glen (S.): Byne Burn.

Petalograptus folium, *His.*—**B.** Baldrennan Burn: Penwhapple Glen (N.).

P. palmaeus, *Barr.*—**B.** Penwhapple Glen (N.): Bargany Pond Burn: Saugh Hill.

Cryptograptus tricornis, *Carr.*—**G.**, **H.** Benan Burn: Millenderdale: Craighead: Pinmore: Penwhapple Glen (S.):—Wandel Burn: Glengonner Burn: Wanlock Water, &c.

Dimorphograptus acuminatus, *Nich.*—**B.** Glenwells Burn.

D. Swanstoni, *Lapw.*—**B.** Penwhapple Glen (N.).

Glossograptus Hincksi, *Hopk.*—**G.** Benan Burn:—Rein Gill: Wandel Water: Glengonner Burn, &c.

Lasiograptus Harknessi, *Nich.*—**G.**, **H.** Laggan Gill: Penwhapple Glen (S.):—Rein Gill: Rough Gill: Castle Hill.

L. margaritatus, *Lapw.*—**H.** Penwhapple Glen (S.): Piedmont Glen:—Rein Gill: Wandel Water: Castle Hill.

Hallograptus bimucronatus, *Nich.*—**G.** Rough Gill: Wandel Burn: Rein Gill: Glengaber Burn, &c.

Trigonograptus ensiformis, *Hall.*—**A.** Balcreuchan Port.

Fam. Retiolitidae.

Retiolites fibratus, *Lapw.*—**H.** Rough Gill?: Grains Burn.

R. Geinitzianus, *Barr.*—**T.**, **W.** Penwhapple Glen (N.): Blair Quarry.

R. obesus, *Lapw.*—**T.** Penwhapple Glen (N.).

Clathrograptus cuneiformis, *Lapw.*—**G.** Benan Burn.

Corynoides calicularis, *Nich.*—**G.**, **H.** Ardmillan Shore; Penwhapple Glen (S.):—Wandel Burn: Glengonner Burn: Laggan Gill.

Thamnograptus typus, *Hall.*—**G.** Wandel Water.

Dictyonema venustum, *Lapw.*—**B.** Penwhapple Glen (N.).

D. delicatulum, *Lapw.*—**B.** Shalloch Forge.

Callograptus diffusus, *Hall.*—**A.** Bennane Head.

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THE OLD RED SANDSTONE OF THE CLYDE AREA.

By J. G. Goodchild, F.G.S.

The rocks usually classed under the general name of the Old Red Sandstone in Scotland consist of four separate formations, three of which are well represented within the basin of the Clyde. These three are widely separated from each other in time, and are linked together chiefly because they collectively occupy a geological position intermediate between that of the Silurian rocks below them and the Carboniferous rocks above. In addition to that they may be said to have had a common origin, seeing that they present various types of rocks formed under continental conditions; in which respect they differ from the strata of marine origin which occur above and below them.

The key to their common characteristics is to be found in the fact that they were all deposited during a period of prolonged terrestrial disturbances during which movements of upheaval predominated, and maintained for long periods at a time climatal conditions of exceptional aridity.

Of the three subdivisions occurring in the basin of the Clyde the lowest has lately been classed as a member of the Silurian rocks. Under the name of the Lower Old Red Sandstone its geological position was accurately described by Murchison and Geikie. But when the fact came to be known that a newer Old Red lay unconformably upon it and was in turn unconformably succeeded by the true Upper Old Red, it became evident that some more distinctive name was needed for the lowest strata of the group, and this was more especially the case when palaeontological evidence rendered it clear that the Orcadian rocks were the true Middle Old Red. I therefore proposed to call these oldest rocks the Lanarkian rocks, with reference to the county in which they are typically represented. When, however, the officers of the Geological Survey re-examined these rocks, and it was found that they appeared to graduate downward into the Silurian rocks, and that they were linked on to them further by containing an ichthyic fauna having the same facies as that found in the associated strata of Silurian age, the name Downtonian was proposed instead, and is now coming into use.

The Downtonian rocks consist of alternating beds of sandstone and mudstone, characterised by reddish and greenish-grey colours, with which are associated one or more bands of fine conglomerate, whose predominant constituents are small pebbles of quartzite, with little or no intermixture of pebbles of greywacke. These strata are interstratified with others of the petrographical types prevalent in the underlying Ludlow rocks. No traces of any volcanic rocks have yet been found in them.

The entire aspect of the group is exactly what might be expected in the case of strata formed under transitional conditions when the area in which they occur was gradually passing from an area of subsidence to one of elevation. The reader will find this subject, and others connected with the origin of the Old Red rocks in general, discussed at some length in the *Proceedings of the Royal Physical Society*, vol. xiii., pp. 291-299.

Considerable interest attaches to this Lanarkian Old Red now that an abundant and varied ichthyic fauna has been discovered in them, which has formed the subject of an important memoir by Dr. Traquair.[1]

I am inclined to think that the Lanarkian rocks were originally of considerable thickness, and that, while the terrestrial oscillations to which they are due were in progress, a band of marine limestone similar to the Plymouth limestone was formed in connection with them. But upon this point there is still some difference of opinion.

This, however, is certain; whatever strata may at one time have been formed in connection with these rocks they soon afterwards underwent considerable disturbance and denudation, which ended in the removal of nearly the whole of the Lanarkian rocks, as well as a considerable thickness—many thousand of feet in all probability—of the older Silurian and Ordovician rocks. Hence it has happened that only a few fragmentary patches of the strata originally formed have been left, and of these a still smaller part has been exposed by later denudation. As a consequence, the Lanarkian rocks are now only to be seen within limited areas. One of these lies in the heart of the Pentland Hills, near the head-waters of the rivers Lyne and North Esk. Another occurs on the flanks of Tinto. The third, and perhaps the most important, occurs in connection with the Silurian outlier of the Logan Water, near Lesmahagow, and near Muirkirk.

The second division of the Old Red, in chronological order, is that great group of strata which forms the Pentland Hills, the Cheviots, the Ochils, the Sidlaws, etc. For this the name Lower Old Red Sandstone is still employed by many geologists; but having regard to the confusion likely to arise from such a use of the term many others consider that it is as well to adopt some more distinctive term, and they therefore refer to these rocks as the Caledonian Old Red, seeing that it may be justly regarded as *par excellence* THE Old Red of Scotland.

This formation, in the area under notice, lies upon an exceptionally uneven surface, which is shaped out of every rock older than the Caledonian Old Red. In other words, there is an extensive and wide-spread unconformity, the base of the Caledonian Old Red overstepping all the rocks older than itself, from the highest surviving member of the Lanarkian Old Red down to the lowest Ordovician rocks occurring in the district. Further, its middle, or even its higher, subdivisions may overlap any one of the lower.

Usually the basement beds consist of purplish- and chocolate-coloured sandstones, which are well seen at the Falls of Clyde, and the area a few miles to the south. Occasionally these are more or less conglomeratic, and very commonly there is at the base a well-marked band of conglomerate which is readily distinguished from the older conglomerate found in connection with the Lanarkian rocks by containing, amongst many other rocks, a large percentage of greywacke pebbles, derived from the waste of the ancient uplands of Silurian and Ordovician strata which formerly occupied the area to the south. This greywacke-conglomerate has been found to be a very useful datum by the officers of the Geological Survey who lately re-mapped the district.

As above remarked, the base of this formation is extremely variable as a consequence, chiefly, of the unevenness of the old land-surface upon which it accumulated. The irregularity is further increased by the fact that important volcanic outbreaks commenced at an early period in the history of the formation, and were continued throughout a period of great length.

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[1] *Trans. R. S. E.*, vol. xxxix., part 3.

Quite commonly one of the ancient lava-streams may be found to end off suddenly, and sandstones, or even conglomerates, may be found side by side with it. This fact has to be borne in mind in considering the geology of the country around Tinto, and also many other areas in the Pentland Hills and elsewhere. On the southeastern flank of Tinto the Caledonian Old Red is represented by a series of andesitic lavas which overstep the various members of the Lanarkian rocks in a manner which impresses one very much with the importance of the chronological break between the two formations. On the opposite side of Tinto we find the basement beds to be simply conglomerates and sandstones, with not a trace of any volcanic rocks amongst them. It is the same elsewhere.

The general character of the Caledonian Old Red is that of a formation accumulated under continental conditions, when a certain degree of aridity characterised the climate. The torrential deposits from the ancient hills to the south were spread out on the lowlands and in the shallow waters of inland lakes, liable to be periodically dried up, wholly or in part. A chain of volcanos contributed occasional streams of lava, mostly of andesitic composition, and now and then explosive eruptions took place, from which beds of tuff, usually of no great thickness, were spread out far and wide over the adjacent land. The volcanos must have attained to considerable dimensions if one may judge by the magnitude of the remnants left. During the active phases of volcanic action some considerable masses of intrusive rock were left at different levels below the surface ; while, at great depths below the volcano, the slow cooling, under enormous pressure, of the last of the volcanic magmas gave rise to several interesting masses of granite, whose dominant petrographical varieties may be termed diorite-granites, but which, as might be expected, locally graduated into more basic, or more acid, varieties. Considerable thermometamorphism arose in connection with these intrusions, as may be seen in many places in the southwestern parts of the basin of the Clyde.

It is difficult, from the very fragmentary and disconnected nature of the existing remnants of the Caledonian Old Red, to form any reliable estimate of what its full thickness may have been. It is certain, however, that the maximum in any part of the basin of the Clyde must have been considerably less than has usually been considered to be the case.

As regards the life of the period when the Caledonian Old Red was being formed the evidence is scanty, and has to be sought chiefly outside the area. It is recorded, however, that the late Mr. Brown of Lanfine once found a specimen of *Cephalaspis Lyelli* in the sandstones near that place. Most of the other fossils recorded from these rocks have been obtained from areas beyond the limit of that specially under notice.

Remains of the Caledonian Old Red occur at several places within the basin of the Clyde. They appear in force near the foot of Loch Lomond, where they form the western end of the great tract constituting the Sidlaws, the Ochils, and Strathmore. Discontinuous patches are exposed at several localities between Lanark and Girvan, and others more extensive are, doubtless, concealed beneath the unconformable covering formed by the newer rocks. A third exposure is to be found in the northern half of the Island of Arran.

The andesitic lavas of these rocks form some of the chief repositories of the Agates or "Scotch Pebbles," for which the land has so long been famous.

The highest group of strata classed under the general name of the Old Red Sandstone is the Upper Old Red. It consists almost entirely of sandstones and conglomerates, which latter occur chiefly in its lower portion. It is characterised, on the whole, by a much brighter-red coloration than either of the others. In its upper part calcareous concretions or "cornstones" occur. These mark the passage-beds into the Carboniferous rocks. They are due (as the writer suggested some years ago) to the reducing action of organic matter upon aqueous solutions of sulphate of lime, and mark a transition-period from the extremely arid climatical conditions which prevailed during the earlier part of the period to the humid conditions which characterised the succeeding Carboniferous times. Everywhere the Upper Old Red lies with a strongly-marked unconformity upon the rocks below, including the granites which are contemporaneous with the Caledonian Old Red volcanic rocks.

The Upper Old Red Sandstone includes no volcanic rocks. It has yielded fossils at a few localities within the basin of the Clyde, chiefly at the Heads of Ayr.

There is some reason to believe that part of the rocks within the Clyde area which have been referred to the Upper Old Red Sandstone may really belong to the Bunter division of the New Red rocks.

THE CARBONIFEROUS ROCKS OF THE CLYDE DRAINAGE AREA.

By John Smith.

The Carboniferous strata of the Clyde drainage area, including the contemporaneous volcanic rocks and the later intrusive sills, reach a total thickness of several thousand feet. Following the divisions adopted by the officers of the Geological Survey the arrangement of the different series may be given as follows :

1. Upper Coal and Ironstone Series.
    - *a.* Red Sandstone, etc.
    - *b.* Coals, Ironstones, Fireclays, Shales, Oil-shales, White and Grey Sandstones.
2. Millstone Grit Series.
3. Upper Limestone Series.
4. Lower Coal and Ironstone Series.
5. Lower Limestone Series.
6. Calciferous Sandstone Series.
    - *a.* Cement Shales, and Grey Sandstones.
    - *b.* Red or Grey Sandstones with Cornstones.

Taking these divisions in ascending order we have first the

Calciferous Sandstone Series.

The strata of this group rest either on Silurian rocks, as at Lady Glen, Kilkerran, or on Old Red Sandstone, as near Sorn. The red or grey sandstones of the division contain few fossils—*Lepidodendron*, *Calamites*, etc.—and the Cornstone beds, once extensively worked near Galston, New Cumnock, Kirkmichael, Dailly, Ayr, Ardrossan, etc., both in opencast quarries and in mines, are now entirely abandoned. They are remarkable deposits, sometimes with layers of chert, containing, amongst the limey material, abundance of sand-grains, pebbles of agate, jasper, quartz, etc., but they are entirely unfossiliferous. In the red sandstones near West Kilbride occur footprints, probably reptilian, worm-trails, rain-prints, ripple-marks and sun-cracks. The cement-shales in the upper part of the series occasionally yield ostracods, fish-remains, and plants, as on the shore between the mouth of the River Doon and the Heads of Ayr, and in the district between Galston and Sorn they contain thin layers, some crowded with *Spirorbis* and others with small bivalves. No truly marine remains have been found in the Calciferous rocks of this area.

Lower Limestone Series.

This series may rest on the cement-beds, but where best developed in the Beith and Dalry districts it rests on a great thickness of volcanic debris which forms the upper part of the Dalry and Kilbirnie Hills. At Wildshaw near Douglas, however, it lies almost directly on the Old Red Sandstone. It contains a large proportion of the marine fauna of the Carboniferous rocks of Scotland. Near Campsie, Paisley, and Beith, it contains a bed with freshwater ostrocoda, and on the top of a thin coal below the lowest limestone in the Beith and Dalry districts a band with *Naiadites crassa.* Above the second limestone in the same localities and also at Kilwinning there is a "fish-bed" in which volcanic debris mixed with the limestone is penetrated by roots and rootlets of *Stigmaria.* Some of the beds of this series were at one time very extensively worked for industrial purposes, but the workings are now confined to a few opencast workings near Beith and some pits near Lesmahagow.

Lower Coals and Ironstone Series.

This series occurs in a succession of strata between the Lower and Upper Limestone series, and its economic bands of ironstone generally occupy the lower part. The coals range from three or four workable seams at Dalry and Kilbirnie to seven or eight at Dalquharran and Muirkirk where the series attains its greatest importance. One of the seams near New Cumnock was 40 feet thick, and the Johnstone coal is said to have been even thicker. There are but few indications of marine conditions having obtained during the deposition of the beds of this series, but many of freshwater ones. Above one of the coal-seams near Giffen there is a thick band crowded with *Naiadites*, and in the lower strata there are occasionally thin layers containing some of the smaller species of *Carbonicola.* In the shales associated with one of the ironstones huge spines of *Gyracanthus* are sparingly got, also *Rhizodus Hibberti*, and sometimes reptilian remains.

Upper Limestone Series.

Like the Lower Limestones these strata attain their full development near Dalry (the very thickest bed in the latter lies to the east of Beith), but they are also well represented near Muirkirk and Barrhead. At the last-named place one of the thicker beds has long been worked as a "cement-stone." They, as a rule, contain more clay than the Lower Limestones, and so have seldom been burned for lime, but some of them yield good hard material for roads. One of the lower beds, known as the "Index limestone" is a "calm lime," that is, a limestone with almost no fossils large enough to be visible to the naked eye, and breaking with a conchoidal fracture. It has been largely used in iron-smelting, building, and agriculture. Chert sometimes occurs in these beds as well as in the Lower Limestones. Marine fossils are occasionally abundant in certain limestone bands and in their under and overlying shales. Under the chief bed of cement-stone at Dalry and at Thornliebank there is a hard shale with *Estheria* and some crustacean remains, and the last of the trilobites occurs in abundance at Bowertrapping. Corals are but feebly represented in this series. Some thick and good white and grey sandstones occur in it. Nearly all the limestone beds rest, as in the Lower Limestones, with very little intervening shale, on thin coal-seams with under clays. A few of these coals swell out in places to a considerable thickness. I have come to the conclusion that the Scottish Carboniferous limestones, as well as those in the north of England, are *sedimentary deposits*, the finer limey material of which they are largely composed having been brought by marine currents from the sea-bed during shallow depressions of the areas over which they extend. Plenty of evidence can be produced in favour of this view, but it is too extensive a subject to be entered upon here.

MILLSTONE GRIT SERIES.

The officers of the Geological Survey have introduced this series into their maps and memoirs, and have for this purpose drawn the base of the Upper Coal and Ironstone series at the slatyband ironstone, and they seem to have come to the conclusion that there is no Millstone Grit in the Kilwinning area. But the slatyband ironstone *does* occur there with several argument from the Survey point of view that there is no occurrence of the of the principal coals of the Upper series under it. If this represents the Millstone Grit it will include all the Upper Limestones and the sandstones immediately above and below the Lower and Upper beds.

UPPER COAL AND IRONSTONE SERIES.

The strata of this series occupy a very large area in Ayrshire and Lanarkshire, and are associated with the usual clays, shales, and white and grey sandstones of the division. Economically, where at its best, it contains about a dozen workable coals and several ironstones. The fossils generally belong to the genera *Anthracomya* and *Carbonicola*, which indicates freshwater or estuarine conditions. *C. robusta* often extends in great "scalps" over large areas. In only one locality—near Coatbridge—do truly marine forms occur in the series, and *Lingula* is got in one or two places in Ayrshire. *Spirorbis* is found attached to plants and shells, *S. helicteris* occurring crowded into thin bands much in the same way as it is in the cementstone (Calciferous) group. Plant-remains occur scattered throughout all the series, or sparingly collected into thin bands known as "fern beds." Several oil-shales occur, and generally yield disjointed remains of fishes and sometimes reptiles. *Gyracanthus* is got, generally in the roof-shales of some of the coal-beds, ostracoda occur in some of the shales and ironstones, and *Belinurus Prestwichia*, *Euphoberia*, *Xylobius*, etc., have been obtained sparingly near Kilmaurs. At its upper part this series generally contains thick beds of reddish or purplish sandstones, shales of the same colours, and thin yellow sandstones. In the shale a thin limestone band with *Spirorbis minutus* occurs, and also burrows filled with shale, as is well seen at Ballochmyle Scar near Catrine. Other bands of limestone are apparently unfossiliferous. [This *Spirorbis* limestone also is found at the top of the Lower Coal series of England, near Manchester, there being twelve bands of it, and what have long been known as "The Upper Coal-measures" of Scotland are now considered to be the equivalents of the English Lower Coal-measures.]

The coal-seams of the Clyde drainage area number in their entirety about seventy, and they are all interesting from a geological point of view. The thin brownish layer—the old land- or swamp-surface—under them often contains a great variety of beautiful microscopic objects—*Triletes* and microspores—with remains of scorpions and eurypterids. These fossils are also got in the coals themselves, the hard layers (when not caused by clay) being often masses of their remains. These layers are called "splint."

The Permian rocks rest unconformably on the Upper Coal and Ironstone series, though sometimes, as in the Snar Valley, on the Silurians.

THE CARBONIFEROUS FOSSIL PLANTS OF THE CLYDE BASIN.

BY ROBERT KIDSTON, F.R.S.E., F.G.S.

IN Britain the Carboniferous formation is divisible into:[1]

Upper Carboniferous.	I. Upper Coal-measures.
	II. Middle Coal-measures.
	III. Lower Coal-measures.
	IV. Millstone Grit Series.
Lower Carboniferous.	V. Carboniferous Limestone Series.
	VI. Calciferous Sandstone Series.

Of these only Nos. III., IV., V., and VI. occur in the Clyde area.

Locally the Lower Coal-measures are referred to as the "Upper Coals and Ironstones," and the coals of the Carboniferous Limestone series as the "Lower Coals and Ironstones," but as these terms are very misleading I have adopted a nomenclature which is applicable to the Carboniferous formation in its entirety in Britain.

One most interesting circumstance in regard to the vertical distribution of the Carboniferous flora is that, as far as observations have yet shown, not a single species (with the exception of *Stigmaria*) passes from the Lower Carboniferous into the Upper Carboniferous.

I am specially indebted for the Lanarkshire Coal-plants to Mr. R. Dunlop and Mr. P. Jack. For the Renfrewshire fossils I have received much assistance from Mr. Peter Macnair, and for the Ayrshire records I am very specially indebted to the Rev. Dr. Landsborough; also to Messrs. A. Sinclair, J. Rorrison, D. Beveridge, J. Stevenson, R. Linton, and others. Mr. J. Smith has submitted to me specimens from the Kilwinning district, and to the same geologist I owe the majority of the records from the Calciferous Sandstone series. To the Director of the Geological Survey of Scotland I owe my thanks for permission to include in the list the plants collected in Arran by Mr. A. Macconochie and Mr. D. Tait, but it is to Dr. W. Ivison Macadam, F.R.S.E., that we owe our first knowledge of the Lower Carboniferous plants of Lochrin Burn. From the late Dr. John Young, the late Mr. A. Paton, and the late Mr. James Bennie, I also received much assistance.

The list is divided into Lower Coal-measures, Carboniferous Limestone series, and Calciferous Sandstone series. In mentioning the horizons of the Coal-measure plants, I merely give the name of the seam, but the fossils have been derived in almost all cases from the shale forming the roof of the coal.

The following list of the various localities may be of assistance in finding them:

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[1] See Kidston, *Proc. Roy. Phys. Soc. Edin.*, vol. xii., 1894, pp. 183-258.

LANARKSHIRE. Auchenheath, Lesmahagow; Bartonshill Pit, Bargeddie, 1 m. W. of Coatbridge; Bent Coll., 1½ m. E. of Bothwell; Bellsdyke Pit, Mains, Airdrie; Brownieside Pit, Mains, Airdrie; Brownrigg Pit, Longriggend, Airdrie; Calderbank, Airdrie; Dunsiston, Gartness, Airdrie; Ellismuir, Baillieston; Gartness, Airdrie; Greengairs, Airdrie; Howlit Glen, Crossford, Lesmahagow; Howlitness, Airdrie; Inkerman Pit, Airdrie: Lochwood, Easterhouse; Longriggend, Airdrie; Souterhouse, Coatbridge; Springhill Pit, Baillieston; Stanrigg, Airdrie; Whiterigg, Airdrie.

AYRSHIRE. Annandale Colliery, Kilmarnock; Ardeer, Stevenston; Bonnington Pit, Kilmarnock; Busbie, Kilmarnock; Bruntswood Mains, Galston; Glenmuir Water; Dalblair, Old Cumnock; Grange Colliery, Kilmarnock; Hillhead, Kilmarnock; Springhill Colliery, Crosshouse; Springside, Dreghorn; Windyedge, Crosshouse; Woodhill Quarry and Colliery, Kilmaurs.

RENFREWSHIRE. Braidwood Quarry, Giffnock.

BUTE. Cock of Arran; Lochrin Burn, Corrie, Arran.

Horizons are printed in *italics* throughout the list.

UPPER CARBONIFEROUS.

Lower Coal-measures.

FILICACEAE.

Sphenopterideae.

Sphenopteris obtusiloba, *Brongt.*—**Lanark.** *Sourmilk Coal,*—Ry. cutting, Airdrie: *Ell Coal,*—Carluke: *Kiltongue Coal,*—Mt. Vernon: Howlitness: Foxley: Bent Col.: Lochwood Col.: *Blaes betw. Kiltongue and Drumgray Coals,*—Whiterigg: *Drumgray Coal,*—Castlehill, Carluke: (*Hor.* ?)—Bothwell: Springhill Pit. **Ayr.** *Small seam* 13 *fms. above M'Naught Coal,*—Grange Col.: *Stranger Coal,*—Grange Col.: *Major Coal,*—3 Pit, Springhill: (*Hor.* ?)—Galston.

S. nummularia, *Gutbier.*—**Lanark.** *Kiltongue Coal,*—Howlitness.

S. Schillingsii, *Andrae.*—**Lanark.** (*Hor.* ?)—Airdrie.

S. latifolia, *Brongt.*—**Lanark.** *Kiltongue Coal,*—Carluke: Mt. Vernon: (*Hor.* ?)—Springhill Pit: Auchenheath: Howlit Glen. **Ayr.** *Stranger Coal,*—Grange Col.: 18 *ft. above Durroch Coal,*—Woodhill Quarry: *Turf Coal,*—Ardeer: (*Hor.* ?)—Galston.

? **S. rotundifolia,** *Andrae.*—**Lanark.** *Shale betw. Kiltongue and Drumgray Coals,*—Whiterigg.

S. rutaefolia, *Gutbier.*—**Lanark.** *Kiltongue Coal,*—Lochwood Col.

S. germanica, *Potonié.*—**Lanark.** *Kiltongue Coal,*—Ellismuir.

? **S. spinosa,** *Göpp.*—**Ayr.** *Stranger Coal,*—Grange Col.

S. furcata, *Brongt.*—**Lanark.** *Sourmilk Coal,*—Ry. cutting, Airdrie: *Main Coal,*—Souterhouse: *Kiltongue Coal,*—Calderbank: Foxley: Souterhouse: Lochwood Col.: *Drumgray Coal,*—Black Pit, Longriggend. **Ayr.** *Major Coal,*—3 Pit, Springhill Col.: 18 *ft. above Durroch Coal,*—Woodhill Quarry: *Whistler Seam,*—Bonnington Pit.

S. Walteri, *Stur.*—**Lanark.** (*Hor.* ?)—River Avon, near Hamilton.

S. Sternbergii, *Ett.*—**Lanark.** *Kiltongue Coal,*—Brownrigg Pit. **Ayr.** 2 *fms. below Ell Coal,*—Busbie Pit, Kilmaurs.

Eremopteris artemisiaefolia, *Sternb.*, **sp.**—**Lanark.** *Kiltongue Coal,*—Souterhouse: (*Hor.* ?)—Howlit Glen: Farme Col., Rutherglen (type of *Sphenopteris stricta*, Brongt.): Bothwell: Carluke. **Ayr.** *Stranger Coal,*—Grange Col.

Renaultia Footneri, *Marrat.*, **sp.**—**Lanark.** *Kiltongue Coal,*—Lochwood Col.: Calder Ironworks: Ellismuir Col.: Mt. Vernon: Calderbank: Foxley. **Ayr.** *Pavement under Tourha' Coal,*—3 Pit, Springhill: *Major Coal,*—3 Pit, Springhill.

Renaultia Schatzlarensis, *Stur.*, **sp.—Lanark.** *Kiltongue Coal,*—Cal. Ry. Bridge, Calderbank.

Urnatopteris tenella, *Brongt.*, **sp.—Lanark.** *Kiltongue Coal,*—Baillieston: Calderbank: Ellismuir: Cairnhill, Airdrie: Howlitness: Rawyards Pit, Airdrie: *L. Drumgray Coal,*—Howlitness: (*Hor.* ?)—Scrawhill Col., Airdrie: Bartonshill Pit, Bargeddie. **Ayr.** *Stranger Coal,*—Grange Col.

Cyclocheta biseriata, *Kidston.*—**Lanark.** *Kiltongue Coal,*—Baillieston.

Pecopterideae.

Mariopteris muricata, *Schl.*, **sp.—Lanark.** *Kiltongue Coal,*—Bent Col.: Calderbank: Greengairs: (*Hor.* ?)—Auchenheath: Tollcross: Chapelhall, Airdrie: *Blaes betw. Kiltongue and U. Drumgray Coals,*—Whiterigg Col. **Ayr.** *Major Coal,*—3 Pit, Springhill: *Stranger Coal,*—Grange Col.: 18 *ft. above Durroch Coal,*—Woodhill Quarry: *Whistler Coal,*—Bonnington Pit: *Kilwinning Main Coal,*—Borough Pit, Irvine: *Main Coal,*—10 Pit, Springside Col.: *Annandale Main Coal,*—Windyedge Pit: (*Hor.* ?)—Hillhead Pit: Gauchallan Pit, Galston: Lucknow Pit, Stevenston. **Bute.** 15 *yds. above junct. with Newer Red Rocks,*—Corrie: 20 *yds. S. of junct. with Newer Red Rocks,*—Shore, Cock of Arran.

M. muricata, var. **nervasa,** *Brongt.* **sp.—Lanark.** *Kiltongue Coal,*—Bent Col.: Mt. Vernon: Calderbank: *U. Drumgray Coal.*—Pit near Calder Ironworks: (*Hor.* ?)—Chapelhall, Airdrie: Howlit Glen. **Ayr.** *Stranger Coal,*—Grange Col.: 18 *ft. above Durroch Coal,*—Woodhill Quarry: (*Hor.* ?)—Lucknow Pit, Stevenston.

Alethopterideae.

Alethopteris lonchitica, *Schl.*, **sp.—Lanark.** *Main Coal,*—Newmains, Cambusnethan: *Kiltongue Coal,*—Foxley: Mt. Vernon: Carluke: Souterhouse: Brownrigg Pit: Bent Col.: Calderbank: Lochwood Col.: Ellismuir Col.: *Blaes betw. Kiltongue and U. Drumgray Coals,*—Whiterigg Col.: (*Hor.* ?)—Holytown: Springhill Pit: Howlit Glen. **Ayr.** 18 *ft. above Durroch Coal,*—Woodhill Quarry: *Whistler Seam,*—Bonnington Pit: 2 *fms. below Ell Coal,*—Busbie Pit: *Splint Coal,*—16 Pit, Woodhill Col.

A. decurrens, *Artis.*, **sp.—Lanark.** *Kiltongue Coal,*—Foxley: Lochwood Col.: *L. Drumgray Coal,*—Bellsdyke Pit: (*Hor.* ?)—Near Holytown. **Ayr.** *Bed betw. Major and Main Coals,*—10 Pit, Springside: *Annandale Main Coal,*—10 Pit, Springside: 18 *ft. above Durroch Coal,*—Woodhill Quarry: *Lin Bed,*—Springhill Col.

Lonchopteris Eschweileriana, *Andrae.*—**Lanark.** *Kiltongue Coal,*—Ellismuir.

Neuropterideae.

Neuropteris heterophylla, *Brongt.*—**Lanark.** *Sourmilk Coal,*—Ry. cutting, Airdrie: *Kiltongue Coal,*—Mt. Vernon: Bent Col.: Foxley: Calderbank: Lochwood Col.: Ellismuir: *Betw. Kiltongue and Drumgray Coals,*—Whiterigg: *U. Drumgray Coal,*—Pit near Calder Ironworks: *L. Drumgray Coal,*—Pit near Coatbridge: (*Hor.* ?)—Howlit Glen. **Ayr.** *M'Naught Coal,*—3 Pit, Springhill: 18 *ft. above Durroch Coal,*—Woodhill Quarry: *Whistler Seam,*—Bonnington Pit: *Major Coal,*—3 Pit, Springhill: *Betw. Major and Main Coals,*—10 Pit, Springside: *Five-quarter Coal,*—Stevenston: *Splint Coal,*—16 Pit, Woodhill Col.: *Lin Bed,*—9 Pit, Annandale Col.: (*Hor.* ?)—Ardeer: Goatfoot Pit, Galston. **Bute.** *About* 15 *yds. above junct. with Newer Red Rocks,*—Lochrin Burn: (*Hor.* ?)—Sliddery Water-head, Arran.

N. obliqua, *Brongt.*, **sp.—Lanark.** *Kiltongue Coal,*—Mt. Vernon: Ellismuir: Brownrigg: Lochwood Col.

Neuropteris gigantea, *Sternb.*—**Lanark.** *Kiltongue Coal,*—Pit at Ry. Sta., Baillieston: Lochwood Col.: Foxley: Greengairs: Bent Col.: Coatbridge. **Ayr.** *About* 18 *ft. above Durroch Coal,*—Woodhill Quarry: *Main Coal,*—Wellington Pit, Hurlford: 10 Pit, Springhill Col.: *Whistler Seam,*—Bonnington Pit: *Lin Bed,*—9 Pit, Annandale Col. (*Hor.* ?)—Hillhead Pit: Goatfoot Pit, Galston. **Bute.** *Above Limestone,* Maoldon, north face, Corrie: 20 *yds. S. of junct. with Newer Red Rocks,*—Shore, Cock of Arran.

N. acuminata, *Schl.* **sp.**—**Lanark.** *Kiltongue Coal,*—Ellismuir: Lochwood Col.: *Blaes betw. Kiltongue and Drumgray Coals,*—Whiterigg Pit.

N. crenata, *Brongt.*—**Ayr.** *About* 18 *ft. above Durroch Coal,*—Woodhill Quarry.

N. Blissii, *Lesqx.*—**Ayr.** *Whistler Seam,*—Bonnington Pit.

Filicaceae. Incertae Sedis.

Rhacophyllum (?) anomalum, *Brongt.*—**Lanark.** *Kiltongue Coal,*—Ellismuir.

CALAMARIEAE.

Group I. Calamitina.

Calamites varians, *Sternb.*—**Lanark.** *U. Drumgray Coal,*—Airdrie. **Bute.** 20 *yds. S. of junct. with Newer Red Rocks,*—Shore, Cock of Arran.

C. varians, var. **insignis,** *Weiss.*—**Ayr.** *About* 18 *ft. above Durroch Coal,*—Woodhill Quarry.

C. approximatus, *Brongt.* (in part).—**Ayr.** *About* 18 *ft. above Durroch Coal,*—Woodhill Quarry: *Five-quarter Coal,*—Stevenston: (*Hor.* ?)—Ardeer: Bruntwood Mains.

C. verticillata, *L. and H.*—**Ayr.** *Major Coal,*—3 Pit, Springhill.

C. Gopperti, *Ett.*—**Ayr.** *Major Coal,*—3 Pit, Springhill.

C. undulata, *Sternb.*—**Lanark.** *Kiltongue Coal.*—Foxley. **Ayr.** *Stranger Coal,*—Grange Pit: *Whistler Seam,*—Bonnington Pit: *Splint Coal,*—16 Pit, Woodhill.

Group II. Eucalamites.

C. ramosus, *Artis.*—**Lanark.** *Kiltongue Coal,*—Foxley: Bent Col.: Mt. Vernon: Calderbank: Bellsdyke Pit: *Blaes betw. Kiltongue and Drumgray Coals,*—Whiterigg: *U. Drumgray Coal,*—Inkerman Pit: *L. Drumgray Coal,*—Pits, Airdrie: *Shale a short distance above Millstone Grit,*—Dennistoun, Glasgow. **Ayr.** *Major Coal,*—3 Pit, Springhill: 18 *ft. above Durroch Coal,*—Woodhill Quarry: *Whistler Seam,*—Bonnington Pit: Irvine Water, near Kilmarnock: *Lin Bed,*—3 Pit, Springhill: (*Hor.* ?)—Galston. **Bute.** *Above Limestones,*—Maoldon, north face, Corrie: 20 *yds. S. of junct. with Newer Red Rocks,*—Shore, Cock of Arran.

Group III. Stylocalamites.

C. Suckowii, *Brongt.*—**Lanark.** *Kiltongue Coal,*—Ellismuir: Bent Col.: Calderbank: Foxley: Bartonshill Pit, Baillieston: Mt. Vernon: Lochwood Col.: *U. Drumgray Coal,*—Inkerman Pit: Pit near Calder Ironworks: *L. Drumgray Coal,*—Pits near Airdrie; *Drumgray Coal,*—Gartness. **Ayr.** *About* 18 *ft. above Durroch Coal,*—Woodhill Quarry: *Major Coal,*—3 Pit, Springhill: *Whistler Seam,*—Bonnington Pit: Dean, Kilmarnock Water: *Turf Coal,*—Redburn, Kilwinning: *Splint Coal,*—10 Pit, Annandale Col.: *Shale near Annandale Main Coal,*—Windyedge: (*Hor* ?)—Hurlford, Kilmarnock: Stevenston: Bruntswood Mains.

C. Cistii, *Brongt.*—**Lanark.** *Kiltongue Coal,*—Lochwood Col.: *L. Drumgray Coal,*—Pit near Calder Ironworks: (*Hor.* ?)—Auchenheath. **Ayr.** (*Hor.* ?)—Streethead Pit, Galston.

Calamocladus equisetiformis, *Schl.*, **sp.—Lanark.** *Kiltongue Coal,*—Bent Col. : Calderbank : Howlitness : Rawyards, Airdrie : Foxley : Ellismuir : *Blaes betw. Kiltongue and Drumgray Coals,*—Whiterigg : *Virtuewell Coal,*—Bellsdyke Pit : *Shale a short distance above Millstone Grit,*—Dennistoun, Glasgow. **Ayr.** *Major Coal,*—3 Pit, Springhill : *M'Naught Coal,*—3 Pit, Springhill : *About* 18 *ft. above Durroch Coal,*—Woodhill Quarry : *Whistler Seam,*—Dean Water, Kilmarnock : 2 *fms. below Ell Coal,*—Busbie Pit : *Lin Bed,*—Cauldhame Pit, Springhill Col. : (*Hor.* ?)—Thornton Quarry, Crosshouse.

C. longifolius, *Sternb.*, **sp.—Lanark.** (*Hor.* ?)—Howlit Glen : *Kiltongue Coal,*—Calderbank (sp. ?) : 10 *yds. below U. Drumgray Coal,*—Longriggend (sp. ?).

C. grandis, *Sternb.*, **sp.—Lanark.** *Kiltongue Coal,*—Bent Col. : Calderbank.

C. lycopodioides, *Zeiller*, **sp.—Lanark.** *Kiltongue Coal,*—Foxley.

Calamostachys typica, *Schimper* (in part).—**Lanark.** *Kiltongue Coal,*—Foxley. **Ayr.** *Stranger Coal,*—Grange Col.

? C. longifolia, *Weiss.*—**Lanark.** *Kiltongue Coal,*—Pit beside Ry. Sta., Baillieston.

? C. nana, *Weiss.*—**Lanark.** *Kiltongue Coal,*—Pit beside Ry. Sta., Baillieston.

Palaeostachya pedunculata, *Will.*—**Lanark.** *Main Coal,*—Craigneuk, Motherwell.

P. gracillima, *Weiss.*—**Lanark.** *Kiltongue Coal,*—Calderbank : Foxley.

Stachannularia northumbriana, *Kidston.*—**Ayr.** *Whistler Seam,*—Bonnington Pit.

Annularia radiata, *Brongt.*—**Lanark.** *Kiltongue Coal,*—Baillieston : Carluke : Longriggend : Howlitness : Calderbank : Foxley : Lochwood Col. : Greengairs : *Main Coal,*—Holytown : *Drumgray Coal,*—Longriggend : *L. Drumgray Coal,*—Pit near Airdrie : *Virtuewell Coal,*—Bellsdyke Pit : (*Hor.* ?)—Howlit Glen : Auchenheath. **Ayr.** *Major Coal,*—3 Pit, Springhill : *About* 18 *ft. above Durroch Coal,*—Woodhill Quarry : *Whistler Seam,*—Bonnington Pit : (*Hor.* ?)—Prince Pit, Stevenston : Galston.

A. galioides, *L. & H.*, **sp.—Ayr.** *Major Coal,*—3 Pit, Springhill.

Sphenophylleae.

Sphenophyllum cuneifolium, *Sternb.* (including forma **saxifragaefolium**, *Sternb.*).—**Lanark.** *Kiltongue Coal,*—Mt. Vernon : Foxley : Bent Col. : Calderbank : Lochwood Col. : *Blaes betw. Kiltongue and Drumgray Coals,*—Whiterigg : *L. Drumgray Coal,*—Pit, Airdrie. **Ayr.** *Major Coal,*—3 Pit, Springhill : *M'Naught Coal,*—3 Pit, Springhill : *About* 18 *ft. above Durroch Coal,*—Woodhill Quarry : *Whistler Seam,*—Bonnington Pit : *Lin Bed,*—3 Pit, Springhill.

S. myriophyllum, *Crépin.*—**Bute.** 20 *yds. S. of junct. with Newer Red Rocks,*—Shore, Cock of Arran.

Lycopodiaceae.

Lepidodendron ophiurus, *Brongt.*—**Lanark.** *Kiltongue Coal*—Bent Col. : Cairnhill, Airdrie : Howlitness : *Sourmilk Coal,*—Ry. cutting, Airdrie : *L. Drumgray Coal,*—Pit, Airdrie : Brownieside Pit : *Drumgray Coal,*—Dunsiston : *Virtuewell Coal,*—Gartlea, Airdrie : *Main Coal,*—Stanrigg : *Oil shale,*—Airdrie : (*Hor.* ?)—Pit, Gartness. **Ayr.** *About* 18 *ft. above Durroch Coal,*—Woodhill Quarry : *Whistler Seam,*—Bonnington Pit : *Main Coal,*—Kilwinning : *Shale betw. Splint Coal and Blackband Ironstone,*—Alnwick Lodge, Irvine : *Hurlford Main Coal,*—New Mill Pit, Kilmarnock : 2 *fms. below Ell Coal,*—Busbie Pits : (*Hor.* ?)—Bruntswood Mains.

L. lycopedioides, *Sternb.*—**Lanark.** *Drumgray Coal,*—Greengairs.

Lepidodendron Landsburgii, *Kidston.*—**Lanark.** *Drumgray Coal,*—Dunsiston. **Ayr.** *Whistler Seam,*—Bonnington Pit.

L. aculeatum, *Sternb.*—**Lanark.** *Humph Coal,*—Airdrie: *Kiltongue Coal,*—Whiterigg: Brownrigg: (*Hor.* ?)—Bellsdyke. **Ayr.** *Stranger Coal,*—Grange Col.: *Whistler Seam,*—Bonnington Pit: Near Stevenston: *Hurlford Main Coal,*—Wellington Pit, Hurlford: (*Hor.* ?)—Bruntswood Mains.

L. aculeatum, forma **modulatum,** *Lesqx.* **Ayr.** *Whistler Seam,*—Bonnington Pit.

L. Jaraczewski, *Zeiller.*—**Lanark.** *Kiltongue Coal,*—Ellismuir: Gartness Col.: Mt. Vernon.

L. Gaudryi, *Renault.*—**Lanark.** *Kiltongue Coal,*—Lochwood Col.: Brownrigg.

L. obovatum, *Sternb.*—**Lanark.** *Kiltongue Coal,*—Mt. Vernon: Foxley: *Blackband Ironstone,*—Stanrigg: *Oil Shales,*—Airdrie: (*Hor.* ?)—Bellsdyke: Coal Burn, Lesmahagow. **Ayr.** *Whistler Seam,*—Bonnington Pit: *Splint Coal,*—9 Pit, Annandale Col.: *Tourha' Coal,*—Cauldhame Pit, Kilmaurs.

L. serpentigerum, *König.*—**Lanark.** *Immediately above Millstone Grit,*—Stanrigg Pit. **Ayr.** *Stranger Coal,*—Grange Col.

L. rimosum, *Sternb.*—**Lanark.** *Drumgray Coal,*—Greengairs.

L. fusiforme, *Corda.*—**Ayr.** *Shale over roof of Durroch Coal,*—Woodhill Pit.

Lepidostrobus variabilis, *L. and H.*—**Lanark.** *Kiltongue Coal,*—Bent Col.: Mt. Vernon: *U. Drumgray Coal,*—Pit near Calder Ironworks: *Drumgray Coal,*—Dunsiston: *Blackband Ironstone,* Airdrie: *Shale a short distance above Millstone Grit,*—Dennistoun, Glasgow. **Ayr.** *About* 18 *ft. above Durroch Coal,*—Woodhill Quarry: *Major Coal,*—3 Pit, Springhill: *Whistler Seam,*—Bonnington Pit: 2 *fms. below Ell Coal,*—Busbie.

L. spinosus, *Kidston.*—**Ayr.** *Whistler Seam,*—Bonnington Pit.

L. squarrosus, *Kidston.*—**Ayr.** *Whistler Seam,*—Bonnington Pit.

L. Geinitzii, *Schimper.*—**Lanark.** (*Hor.* ?)—Airdrie: Pit, Calder Ironworks. **Ayr.** *Blackband Ironstone,*—Dalmellington: 2 *fms. below Ell Coal,*—Busbie Pits: *Ironstone Bed betw. Raise Road Coal and Calm Limestone,*—Rankinston.

Lepidophyllum lanceolatum, *L. and H.*—**Lanark.** *Kiltongue Coal,*—Bent Col.: Calderbank: Lochwood Col.: *L. Drumgray Coal,*—Pit, Airdrie. **Ayr.** 18 *ft. above Durroch Coal,*—Woodhill Quarry.

L. intermedium, *L. and H.*—**Lanark.** *Kiltongue Coal,*—Calderbank.

Lepidophloios acerosus, *L. and H.,* **sp.**—**Lanark.** *Kiltongue Coal,*—Foxley: Calderbank: Lochwood Col.: Greengairs: Brownrigg: *L. Drumgray Coal,*—Pit near Coatbridge. **Ayr.** *Durroch Coal,*—Woodhill Old Pit: *Whistler Seam,*—Bonnington Pit.

Halonia, *L. and H.*—(Decorticated fruiting branch of *Lepidophloios.*)

H. regularis, *L. and H.*—**Ayr.** 18 *ft. above Durroch Coal,*—Woodhill Quarry: *Whistler Seam,*—Bonnington Pit: *Blackband Ironstone,*—Dalmellington: (?) Ardeer Quarry.

Bothrodendron punctatum, *L. and H.*—**Ayr.** *Major Coal,*—3 Pit, Springhill: *Whistler Seam,*—Bonnington Pit.

B. minutifolium, *Boulay.*—**Lanark.** *Kiltongue Coal,*—Calderbank: Ellismuir: Lochwood Col.: *Blaes betw. Kiltongue and Drumgray Coals,*—Whiterigg. **Ayr.** *Whistler Seam,*—Bonnington Pit.

Sigillaria discophora, *König.*—**Lanark.** *Kiltongue Coal,*—Shettleston: Howlitness: *Drumgray Coal,*—Dunsiston: *L. Drumgray Coal,*—Toad Pit, Airdrie: *Humph Coal,*—Airdrie: (*Hor.* ?)—Shotts Ironworks. **Ayr.** *Whistler Seam,*—Bonnington Pit: Borland Water, Kilmarnock: 2 *fms. below Ell Coal,*—Busbie Pits: *Parrot Coal,*—10 Pit, Springside Col.:

Blackband Ironstone,—Dalmellington: *Ironstone Bed betw. Raise Road Coal and Calm Limestone,*—Rankinston.

Sigillaria camptotaenia, *Wood,* **sp.—Ayr.** *Major Coal,*—3 Pit, Springhill.

S. tessellata, *Brongt.*—**Ayr.** *Tourha' Coal,*—Bonnington Pit.

S. scutellata, *Brongt.*—**Lanark.** *Kiltongue Coal,*—Bent Col.: *Bed betw. Pyotshaw and Main Coals,*—Whiterigg: *Main Coal,*—Stanrigg. **Ayr.** *Whistler Seam,*—Bonnington Pit.

S. Walchii, *Sauveur.*—**Ayr.** *Turf Coal,*—Kilwinning.

S. Arzinensis, *Corda.*—**Ayr.** *Main Coal,*—Annandale Col.

S. orbicularis, *Brongt.*—**Ayr.** *Whistler Seam,*—Bonnington Pit.

S. laevigata, *Brongt.,* var.—**Lanark.** *Kiltongue Coal,*—Mt. Vernon.

Sigillariostrobus, sp.—Ayr. *Major Coal,*—3 Pit, Springhill.

Stigmaria ficoides, *Sternb.,* **sp.—Lanark.** Common. **Ayr.** Common.

S. reticulata, *Göpp.*—**Lanark.** *Betw. Pyotshaw and Main Coals,*—Airdrie. **Ayr.** *Major Coal,*—3 Pit, Springhill: *M'Naught Coal,*—4 Pit, Springhill: *Splint Coal,*—Annandale Pit.

CORDAITEAE.

Cordaites principalis, *Germar.,* **sp.—Lanark.** *Kiltongue Coal,*—Bent Col.: *U. Drumgray Coal,*—Pit near Calder Ironworks: *L. Drumgray Coal,*—Brownieside Pit. **Ayr.** *Stranger Coal,*—Grange Pit: *Major Coal,*—3 Pit, Springhill: *Whistler Seam,*—Bonnington Pit. **Bute.** 72 *yds. from junct. with Newer Red Rocks*: 20 *yds. S. of junct. with Newer Red Rocks,*—Shore, Cock of Arran.

Cordaianthus Pitcairniae, *L. and H.,* **sp.** (including *Cardiocarpus acutus, L. and H.*).—**Lanark.** *Kiltongue Coal,*—Brownrigg: Bent Col.: Foxley: Greengairs: *U. Drumgray Coal,*—Longriggend. **Ayr.** *Stranger Coal,*—Grange Col.: *Major Coal,*—3 Pit, Springhill; *Whistler Seam,*—Bonnington Pit: (*Hor.* ?)—Borough Pit, Irvine.

Cardiocarpus crassus, *Lesqx.*—**Lanark.** *Kiltongue Coal,*—Greengairs: Ellismuir.

C. orbicularis, *Ett.*—**Ayr.** *Major Coal,*—3 Pit, Springhill.

Carpolithus perpusillus, *Lesqx.*—**Lanark.** *Kiltongue Coal,*—Rawyards, Airdrie: Howlitness; Bredisholm, Baillieston. **Ayr.** *Small Coal,* 13 *fms. above M'Naught Coal,*—Grange Col.: *Whistler Seam,*—Bonnington Pit.

Trigonocarpus Parkinsoni, *Brongt.*—**Lanark.** *Kiltongue Coal,*—Foxley: Souterhouse: Pit near Coatbridge: Mt. Vernon: Lochwood Col.: *Shale a short distance above Millstone Grit,*—Dennistoun, Glasgow. **Ayr.** *Whistler Seam,*—Bonnington Pit: *Sandstone-Conglomerate roof of Five-quarter Coal,*—Ardeer Quarry.

T. Parkinsoni, forma **alata,** *L. and H.,* **sp.—Ayr.** *Whistler Seam,*—Bonnington Pit.

Rhabdocarpus elongatus, *Kidston.*—**Lanark.** *Kiltongue Coal,*—Mt. Vernon: Calderbank: Greengairs: Foxley. **Ayr.** *Major Coal,*—3 Pit, Springhill.

Artisia approximata, *Brongt.*—**Lanark.** *Kiltongue Coal,*—Brownrigg. **Ayr.** *Whistler Coal,*—Bonnington Pit: *Five-quarter Coal,*—Ardeer.

Pinnularia capillacea, *L. and H.*—**Lanark.** *Kiltongue Coal,*—Foxley: Lochwood Col.: (*Hor.* ?)—Airdrie: Castlehill, Carluke. **Ayr.** *Whistler Seam,*—Bonnington Pit: *Major Coal,*—3 Pit, Springhill: *Bed betw. Major and Main Coals,*—3 Pit, Springhill.

INCERTAE SEDIS.

Psitotites unilateralis, *Kidston,* **sp.—Lanark.** (*Hor.* ?)—Baillieston.

LOWER CARBONIFEROUS.

Carboniferous Limestone Series.

ALGAE.

Spirophyton cauda-galli, *Vanuxem*, **sp.—Stirling.** Corrieburn, Campsie: Spouthead Burn, Milton of Campsie. **Ayr.** Den, Dalry.

FILICACEAE.

Sphenopterideae.

Sphenopteris Ettingshauseni, *Feistm.*—**Lanark.** *Calderwood Group*,—E. Kilbride.
S. Haueri, *Stur.*—**Lanark.** *Calderwood Group*,—E. Kilbride.
S. elegans, *Brongt.*—**Renfrew.** *Immediately under Orchard Limestone*,—New Braidbar Quarry.
S. moravica, *Ett.*—**Renfrew.** *Immediately under Orchard Limestone*,—New Braidbar Quarry.
S. subtrifida, *Stur.*—**Renfrew.** *Immediately under Orchard Limestone*,—New Braidbar Quarry.
S. Gersdorfii, *Göpp*, **sp.—Lanark.** *Calderwood Group*,—E. Kilbride.
Sphenopteridium dissectum, *Göpp*, **sp.—Lanark.** *Calderwood Group*,—E. Kilbride. **Bute.** *Shale over U. Limestone*,—Waterfall, Lochrin Burn.
Rhacopteris inaequilatera, *Göpp*, **sp.**—(*Adiomtites Lindseaeformis, Bunbury.*) **Lanark.** *Calderwood Group*,—Kirktonholm, and Burnbrae Old Quarry E. Kilbride: (*Hor.* ?)—Braidwood.
R. transitionis, *Stur.*—**Lanark.** *Calderwood Group*,—E. Kilbride.
? R. petiolata, *Göpp*, **sp.—Lanark.** *Calderwood Group*,—E. Kilbride.
Adiantites Machaneki, *Stur.*—**Lanark.** *Calderwood Group*,—E. Kilbride.
A. bellidulus, *Heer.*—**Bute.** Sliddery Water-head, Arran.
Archaeopteris Tschermaki. *Stur.*—**Lanark.** *Calderwood Group*,—E. Kilbride.
Plumatopteris elegans, *Kidston.*—**Lanark.** *Calderwood Group*,—E. Kilbride.
Calymmatotheca Stangeri, *Stur.*—**Renfrew.** *Immediately under Orchard Limestone*,—New Braidbar Quarry.

Pecopterideae.

Dactylotheca aspera, *Brongt.*, **sp.—Renfrew.** *Immediately under Orchard Limestone*,—New Braidbar Quarry.

Neuropterideae.

Neuropteris antecedens, *Stur.*—**Lanark.** *Calderwood Group*,—E. Kilbride.
Cardiopteris nana, *Eichwald*, **sp.—Lanark.** *Calderwood Group*,—E. Kilbride. **Bute.** 130 *yds. N. of Hurlet Limestone*,—Shore, N. of Laggan, Arran.

CALAMARIEAE.

Asterocalamites scrobiculatus, *Schl.*, **sp.—Lanark.** *Calderwood Group*,—E. Kilbride. **Renfrew.** *Immediately under Orchard Limestone*,—New Braidbar Quarry. **Bute.** *Shale over U. Limestone*,—Waterfall, Lochrin Burn. *In Tuff*,—Sliddery Water-head, Arran.
Volkmannia Morrisii, *Hooker.*—**Lanark.** *Ironstone midway betw. Cannel Coal and Main Limestone*,—Carluke.

SPHENOPHYLLEAE.

Sphenophyllum tenerrimum, *Ett.*—**Lanark.** *Possil Ironstone series, horizon of Robroyston Limestone*,—Robroyston.

LYCOPODIACEAE.

Lepidodendron Veltheimianum, *Sternb.*—**Lanark**. *Possil Ironstone series*,—Victoria Park, Whiteinch : Possil : Keppoch Hill : *Calderwood Group*,—Limekilns, E. Kilbride : (*Hor.* ?)—Carluke. **Ayr**. *Clayband Ironstone*,—Dalry. **Renfrew**. *Immediately under Orchard Limestone*,—New Braidbar Quarry. **Bute**. *Shale over U. Limestone*,—Waterfall, Lochrin Burn : *In Tuff*,—Sliddery Water-head, Arran.

L. spetsbergense, *Nathorst.*—**Renfrew**. *Immediately under Orchard Limestone*,—New Braidbar Quarry.

L. Rhodeanum, *Sternb.*—**Lanark**. *Calderwood Group*,—E. Kilbride. **Renfrew**. *Immediately under Orchard Limestone*,—New Braidbar Quarry. **Bute**. *Shale over U. Limestone*,—Waterfall, Lochrin Burn.

Lepidophloios Wunschianus, *Will.*—**Bute**. *Volcanic Ash*,—Laggan Burn, Arran.

Sigillaria Taylori, *Carr.*—**Renfrew**. *Immediately under Orchard Limestone*, —New Braidbar Quarry.

S. Youngiana, *Kidston.*—**Lanark**. *Possil Ironstone series*,—Robroyston.

Stigmaria ficoides, *Sternb.*, **sp.**—Common.

S. stellata, *Göpp.*—**Bute**. *Shale over U. Limestone*,—Waterfall, Lochrin Burn. **Ayr**. *Loose in Boulder-clay*,—Bent, Galston : Bruntswood Mains : Townhead, Riccarton : (*Hor.* ?)—Stream near Darvel.

CORDAITEAE.

Carpolithus sulcatus, *L. and H.*—**Bute**. *Shale over Upper Limestone*,—Waterfall, Lochrin Burn.

Trigonocarpum Gloagianum, *J. Young.*—**Lanark**. *Calderwood Group*,—E. Kilbride.

Calciferous Sandstone Series.

FILICACEAE.

Sphenophterideae.

Sphenopteris elegans, *Brongt.*—**Ayr**. Glenmuir Water.

S. moravica, *Ett.*—**Ayr**. Glenmuir Water.

Sphenophylleae.

Sphenophyllum tenerrimum, *Ett.*—**Ayr**. Glenmuir Water.

Lycopodiaceae.

Stigmaria ficoides, *Sternb.*—**Dumbarton**. Glenarbuck, Bowling.

CORDAITEAE.

Araucarioxylon fasciculare, *Scott.*—**Dumbarton**. L. Humphrey Burn, Kilpatrick Hills.

THE CARBONIFEROUS FORAMINIFERA OF THE CLYDE DRAINAGE AREA.

BY (THE LATE) JOHN YOUNG, LL.D., F.G.S.

THE Carboniferous Foraminifera of the West of Scotland are found in nearly all the fossiliferous Marine Limestones and their accompanying shales, though certain forms are often restricted to particular horizons and localities. During the earliest years of research specimens were almost entirely obtained from the weathered and rotted limestones and shales, which, on being carefully washed and examined, yielded a considerable number of species, but more recently, through the use of transparent sections ground down from the harder strata, many interesting species have been added to the lists.

When the late Dr. H. B. Brady began his well-known Monograph on "The British Carboniferous Foraminifera," issued by the Palaeontographical Society in 1876, nearly all the genera and species of foraminifera submitted for his determination were sent as single specimens detached from the rock-matrix, and he had to section many of them to transparency, often with considerable difficulty, in order to obtain a knowledge of their shell-walls and internal structure. Had the same work now to be gone through Dr. Brady would have been spared much labour by the aid of the many microscopic sections which would have been at his disposal.

Further particulars of the West of Scotland foraminifera will be found in a paper by the late Dr. Young, which he read before the Geological Society of Glasgow in 1891.[1]

The divisions of the Carboniferous rocks which yield the foraminifera are indicated in the following list by heavy letters—**U. L. S.**, Upper Limestone Series; **L. L. S.**, Lower Limestone Series.

Lituola Bennieana, *Brady*.—**U.L.S.** Linn, Dalry.

Saccammina Carteri, *Brady*.—**L.L.S.** Braidwood, Carluke, Campsie, Beith, (Main Limestone).

Climacammina antiqua, *Brady*.—**L.L.S.** Muirkirk.

Trochammina incerta (*d'Orb.*).—**L.L.S.**, **U.L.S.** Muirkirk, Robroyston, Dalry.

T. centrifuga, *Brady*.—**L.L.S.**, **U.L.S.** Muirkirk, Robroyston, Dalry.

T. annularis, *Brady*.—**L.L.S.** Capelrig, Kilbride.

T. gordialis, *P. and J.*—**L.L.S.** South Shields, Kilbride, Dalry.

T. pusilla (*Geinitz*).—**L.L.S.**, **U.L.S.** Trearne, Beith, Gare, Carluke.

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[1] "Notes on a small group of Carboniferous Foraminifera found in the Lower Limestone Shales of the Muirkirk district in Ayrshire, with a list of the Genera and Species found in the Coal-fields of Western Scotland." By John Young, F.G.S., *V.P. Trans. Geol. Soc. of Glasgow*, vol. ix., part 2, 1893, p. 313.

Trochammina anceps, *Brady*.—**L.L.S.** Capelrig.
T. Robertsoni, *Brady*.—**U.L.S.** Gare, Carluke.
Valvulina palaeotrochus, *Ehrenb*.—**L.L.S.**, **U.L.S.** Robroyston, Brockley, Beith, Muirkirk, Dalry.
V. palaeotrochus, var. **compressa**, *Brady*.—**L.L.S.**, **U.L.S.** Gare, Carluke, Brockley, Muirkirk.
V. Youngi, *Brady*.—**L.L.S.** Brockley, Trearne, Dalry, Muirkirk, Campsie.
V. Youngi, var. **contraria**, *Brady*.—**L.L.S.** Brockley, Trearne, Beith.
V. bulloides, *Brady*.—**L.L.S.** Brockley.
V. decurrens, *Brady*.—**L.L.S.**, **U.L.S.** Gare, Carluke, Brockley, Muirkirk, Dalry.
V. plicata, *Brady*.—**L.L.S.** Calderside, Blantyre, Hairmyres.
V. rudis, *Brady*.—**L.L.S.** Headsmuir, Carluke.
Endothyra Bowmanni, *Phill*.—**L.L.S.**, **U.L.S.** Calderside, Trearne, Dalry Muirkirk.
E. ammonoides, *Brady*.—**L.L.S.**, **U.L.S.** Gare, Gillfoot, Carluke, Dalry, Muirkirk.
E. globolus (*Eichw.*).—**L.L.S.**, **U.L.S.** Gillfoot, Braidwood, Muirkirk.
E. crassa, *Brady*.—**L.L.S.**, **U.L.S.** Brockley, Muirkirk, Beith.
E. radiata, *Brady*.—**L.L.S.**, **U.L.S.** Robroyston, Gillfoot, Brockley, Muirkirk.
E. macella, *Brady*.—**L.L.S.** Brockley, Muirkirk.
E. ornata, *Brady*.—**L.L.S.** Brockley, Muirkirk.
E. ornata, var. **tenuis**, *Brady*.—**U.L.S.** Robroyston, Barmulloch.
E. subtilissima, *Brady*.—**L.L.S.** Brockley.
Stacheia marginulinoides, *Brady*.—**L.L.S.** Brockley.
S. fusiformis, *Brady*.—**L.L.S.** Belston Burn, Brockley.
S. pupoides, *Brady*.—**L.L.S.** Brockley, Hairmyres.
S. acervalis, *Brady*.—**L.L.S.** Hairmyres, Gare, Carluke.
S. congesta, *Brady*.—**L.L.S.**, **U.L.S.** Belston Burn, Carluke, Limekilns.
S. polytrematoides, *Brady*.—**L.L.S.**, **U.L.S.** Gare, Braidwood, Hairmyres, Muirkirk.
Lagena Parkeriana, *Brady*.—**U.L.S.** Belston Burn, Carluke.
L. Howchiniana, *Brady*.—**U.L.S.** Belston Burn, Carluke, Muirkirk, Gillfoot.
Nodosinella concinna, *Brady*.—**U.L.S.** Belston Burn, Carluke, Muirkirk.
* **N. digitata**, *Brady*.—**U.L.S.** Muirkirk.
N. cylindrica, *Brady*.—**U.L.S.** Muirkirk.
* **Nodosaria radicula**, *Linné*.—**U.L.S.** Clonbeith, Kilwinning ; Stacklawhill, Stewarton.
Textularia gibbosa (*d'Orb.*).—**L.L.S.** Brockley, Muirkirk, Dalry.
T. eximia (*Eichw.*).—**L.L.S.** Brockley, Muirkirk.
T. sp., undetermined.—**L.L.S.** Muirkirk.
Bigenerina patula, *Brady*.—**L.L.S.** Headsmuir, Carluke.
Archaediscus Karreri, *Brady*.—**L.L.S.**, **U.L.S.** Craigenglen, Brockley, Muirkirk, Belston Burn, Beith.
Girvanella sp. (*Nich. and Ether.*).—**L.L.S.** Muirkirk, Law Quarry, Dalry.
Haplophragmium rectum (?) *Brady*.—**L.L.S.** Hillhead Quarry, Beith.
Globigerina sp.—**L.L.S.** Beith, Campsie, Dalry, Muirkirk.
Pulvinulina Broeckiana, *Brady*.—**L.L.S.** Craigie.

Those marked * are Permian species not hitherto recorded from the Carboniferous rocks. *Nodosinella* is new to Scotland, but recorded for England and Wales. *Pulvinulina Broeckiana* is a Belgian species new to Britain. *Lituola Bennieana* was hitherto doubtfully recorded from Levenseat.—J. S.

THE CARBONIFEROUS SPONGES OF THE CLYDE DRAINAGE AREA.

BY JOHN SMITH.

IN 1876 I discovered remains of Sponges in the Carboniferous Limestone strata—both the Lower and Upper divisions. These were described by Prof. John Young and Dr. John Young, F.G.S., in the "Catalogue of Western Scottish Fossils," 1876, and in the *Annals and Magazine of Natural History*, 1877. They have since been more exhaustively treated by Dr. G. J. Hinde in his Monograph on "Fossil Sponges" issued by the Palaeontographical Society, and in his "Catalogue of Fossil Sponges in the British Museum."

With perhaps the exception of *Acanthactinella Benniei*, which may have been a sponge with calcareous spicules, all those found in the Carboniferous rocks of the Clyde drainage area appear to have been furnished with siliceous spiculae, and a peculiarity is the immense size of the spicules compared with those of recent sponges.

They occur in both the Lower and Upper Limestones, but most abundantly in the upper divisions of the Lower Limestones, and though generally in the limestone strata, only occasionally in the shales.

The divisions are indicated in the following list in heavy letters placed before the localities—**U. L. S.**, Upper Limestone Series; **L. L. S.**, Lower Limestone Series.

Hyalostelia (Hyalonema) Smithi, *Young and Young.*—**L. L. S.**, Cunningham-Baidland, Law; Birkhead and Auchenskeith, Dalry; Dykes, Kilbirnie.

Hyalonema parallela, *M'Coy.*—**L. L. S.**, Auchenskeith: Dockra, Gateside, Beith; Brockley near Lesmahagow.

Tholiasterella Youngi, *Hinde.*—**L. L. S.**, Law and Thirdpart, Dalry; Dykes; **U. L. S.**, Glencart, Dalry.

T. gracilis, *Hinde.*—**L. L. S.**, Law; Dykes; Cunningham-Baidland; **U. L. S.**, Stacklawhill, Stewarton.

T. compacta, *Hinde.*—**L. L. S.**, Cunningham-Baidland; Law.

T. crassa, *Hinde.*—**L. L. S.**, Crawfield, Kilbirnie; Law.

Holasterella conferta, *Carter.*—**L. L. S.**, Dalry.

Asteractinella tumida, *Hinde.*—**L. L. S.**, Law.

A. expansa, *Hinde.* - **L. L. S.**, Blackstone, Dalry; **U. L. S.**, Stacklawhill.

Geodites deformis, *Hinde.*—**L. L. S.**, Law.

G. antiquus, *Hinde.*—**L. L. S.**, Cunningham-Baidland; **U. L. S.**, Glencart.

Haplistion Armstrongi, *Y. and Y.*—**L. L. S.**, Law; Cunningham-Baidland.

H. vermiculatum, *Carter.*—**L. L. S.**, Law.

Acanthactinella Benniei, *Hinde.*—**L. L. S.**, Law; Cunningham-Baidland.

Dorydemia dalryense, *Hinde.*—**U. L. S.**, Monkcastle, Kilwinning.

Axinella vetusta, *Hinde.*—**L. L. S.**, Law; **U. L. S.**, Glencart.

Pachastrella vetusta, *Hinde.*—**L. L. S.**, Law.

THE CARBONIFEROUS CORALS OF THE CLYDE DRAINAGE AREA.

BY (THE LATE) JAMES THOMSON, F.G.S.

THIS list of the Carboniferous Corals of the Clyde drainage area was drawn up by Mr. Thomson only shortly before his death in 1899, and therefore has not had the benefit of his revision in print. So far as possible it has been compared with an exhaustive paper on the Scottish Carboniferous Corals, which Mr. Thomson read before the Philosophical Society of Glasgow in 1883, and which was published at length in its *Transactions*, accompanied by 14 plates with numerous figures.[1]

Aulopora campanulata (*M'Coy*).—Wistown, Lanarkshire.
A. gracilis (*Thomson*).—Broadstone, Beith.
Cladochonus crassus (*M'Coy*).—Brockley, Lesmahagow.
C. bacillarius (*M'Coy*).—Auchenskeith, Dalry.
C. antiquus (*M'Coy*).—Auchenskeith, Dalry.
C. Michelini (*Edw. and Haime*).—Howood, near Paisley; Auchenskeith, Dalry.
C. minutus (*Thom.*).—Auchenskeith, Dalry.
Pyrgia Labechei (*Edwards and Haime*).—Cunningham-Baidland, Dalry.
Protocyatohphyllum quadrophyllum (*Thom.*).—Cunningham-Baidland, Dalry.
P. plicatum (*Thomson*).—Cunningham-Baidland, Dalry.
P. spinulosum (*Thom.*).— ” ” ”
P. elegans (*Thom.*).— ” ” ”
P. Verilliense (*Thom.*).— ” ” ”
P. dalryense (*Thom.*).— ” ” ”
P. pachytheca (*Thom.*).— ” ” ”
P. quadrophyllum (*Thom.*).—Cunningham-Baidland, Dalry.
Chaetetes tumidus (*Phillips*).—Brockley, Lesmahagow, and in almost every bed of limestone in the series.
Monticulipora alveolites (*d'Orb.*).—(Lanark).
M. depressa (*Edw. and Haime*).—Garsewater and Asheyburn, near Muirkirk.
M. Etheridgei (*Thom.*).—Asheyburn, near Muirkirk.
Michelinia tenuisepta (*Edw. and Haime*).—Broadstone, Beith.
Favosites parasitica (*Phill.*).—Brockley, Lesmahagow.
Fistulipora sp. nov.—Brockley, Lesmahagow.
Alveolites depressa (*Edw. and Haime*).—Garsewater and Asheyburn.
A. Etheridgei (*Thom.*).—Asheyburn.

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[1] "On the Development and Generic Relation of the Corals of the Carboniferous System of Scotland." By James Thomson, F.G.S. *Proc. Phil. Soc. of Glasgow*, vol. xiv., 1883, pp. 296-502, plates i. to xiv.

Amplexus Sowerbyi (*Phill.*).—Brockley, Lesmahagow.
A. serpuloides (*de Kon.*).—Brockley, Lesmahagow.
A. modulosus (*Phill.*).— „ „
A. spinosus (*de Kon.*).— „ „
A. coralloides (*Sow.*).—Broadstone, Beith.
A. Haimeanus (*de Kon.*).—Brockley, Lesmahagow.
A. Henslowi (*Ed. and Haime*).—Broadstone, Beith.
A. cornuformis (*Ludwig*).—Brockley, Lesmahagow.
Calophyllum Danai (*Thom.*).—Roughwood, Beith.
C. spinosum (*Thom.*).—Auchenskeith, Dalry.
C. tuberculatum (*Thom.*).—Brockley, Lesmahagow.
C. irregularum (*Thom.*).—Auchenskeith, Dalry.
C. honiana (*de Kon.*).— „ „
C. cuspidum (*Thom.*).—Brockley, Lesmahagow.
C. nodosum (*Thom.*).— „ „
C. angularum (*Thom.*).—Auchenskeith, Dalry.
C. denticulatum (*Thom.*).—Brockley, Lesmahagow.
C. robustum (*Thom.*).—Roughwood, Beith.
C. approximatum (*Thom.*).—Roughwood, Beith.
Zaphrentis Edwardsiana (*de Kon.*).—Boghead, Hamilton.
Z. Phillipsi (*Ed. and Haime*).—Auchenskeith, Dalry.
Z. curvulina (*Thom.*).—Brockley, Lanarkshire.
Z. tuberculatus (*Thom.*).— „ „
Z. granulatus (*Thom.*).— „ „
Z. spinulosa (*Ed. and Haime*).—Brockley, Lesmahagow
Z. bicentrica (*Thom.*).— „ „
Z. centralis (*Ed. and Haime*).—Broadstone, Beith.
Z. clavatus (*Thom.*).—Brockley, Lesmahagow.
Z. Konincki (*Ed. and Haime*).—Auchenskeith, Dalry.
Z. amphitheca (*Thom.*).—Brockley, Lesmahagow.
Z. vermicularis (*de Kon.*). „ „
Z. intermedia (*de Kon.*).—Gare, Carluke.
Z. Smithi (*Thom.*).—Auchenskeith, Dalry.
Z. patula (*Michelin*).—Beith, Ayrshire.
Z. Guerangeri (*Ed. and Haime*).—Auchenskeith, Dalry.
Z. Bowerbanki (*Ed. and Haime*).—Shields, E. Kilbride.
Z. Cliffordiana (*Ed. and Haime*).—Boghead, Hamilton.
Z. Enniskilleni (*Ed. and Haime*).—Roughwood, Beith.
Heterophyllia Sedgwicki (*Duncan*).—Brockley, Lesmahagow.
H. M'Coyi (*Duncan*).—Brockley, Lesmahagow.
H. Lyelli (*Duncan*).—Craigenglen, Campsie.
H. mirabilis (*Duncan*).— „ „
Densyphyllum granulatum (*Thom.*).—Brockley, Lesmahagow.
D. minutum (*Thom.*).—Nethernewton, Loudon, Ayrshire.
Lophophyllum parvulum (*Nich. and Thom.*).—Shields, E. Kilbride.
L. reticulatum (*Nich. and Thom.*).—Shields, E. Kilbride.
L. scoticum (*Nich. and Thom.*).—Brockley, Lesmahagow.
L. eruca (*M'Coy*).—Auchenskeith, Dalry.
L. intermedium (*Thom.*). —Shields, E. Kilbride.
Campophyllum Murchisoni (*Ed. and Haime*).—Brockley, Lesmahagow.
C. brockleyensis (*Thom.*).—Brockley, Lesmahagow.
C. simplicum (*Thom.*).— „ „
C. recurvatum (*Thom.*).— „ „
C. breviseptum (*Thom.*).—Nettlehirst, Beith.
C. laxicum (*Thom.*).—Brockley, Lesmahagow.
C. dissimilis (*Thom.*).— „ „
C. heteroseptum (*Thom.*).—Brockley, Lesmahagow.

Campophyllum turcatum (*Thom.*).—Cunningham-Baidland, Dalry.
C. rectangularum (*Thom.*).—Brockley, Lesmahagow.
C. dendriformum (*Thom.*).— „ „
C. subclaviformis (*Thom.*).— „ „
C. turbinatum (*Thom.*).— „ „
C. concavum (*Thom.*).—Broadstone, Beith.
C. marginatum (*Thom.*).—Brockley, Lesmahagow.
C. interruptum (*Thom. and Nich.*).—Brockley, Lesmahagow.
C. parricida (*M'Coy*).—Brockley, Lesmahagow; Broadstone, Beith, and Asheyburn, Muirkirk.
C. echinatum (*Thom.*).—Brockley, Lesmahagow.
C. asheyburnense (*Thom.*).—Asheyburn, Muirkirk.
C. radiolarium (*Thom.*).— „ „
C. dendriformum (*Thom.*).—Howrat, Dalry.
C. eleganteum (*Thom.*).—Corrieburn, Campsie.
C. Agassizi (*Thom.*).—Asheyburn, Muirkirk.
C. domiformum (*Thom.*).—Brockley, Lesmahagow.
C. tuberculatum (*Thom.*).—Asheyburn, Muirkirk.
C. Taylori (*Thom.*).—Brockley, Lesmahagow.
C. intercellulosum (*Thom.*).—Broadstone, Beith.
C. subclavatum (*Thom.*).—Howrat, Dalry.
C. crumlatum (*Thom.*).—Asheyburn, Muirkirk.
C. clavatum (*Thom.*).—Brockley, Lesmahagow.
C. fasiculatum (*Thom.*).— „ „
Cyathaxonia profunda (*Thom.*).—Cunningham-Baidland, Dalry.
C. tortuosa (*Münster*).—Cunningham-Baidland, Dalry.
C. domiformis (*Thom.*).— „ „ „
C. Dybowskii (*Thom.*).— „ „ „
C. elegans (*Thom.*).— „ „ „
C. compressa (*Thom.*).— „ „ „
C. expansa (*Thom.*).— „ „ „
C. cornua (*de Kon.*).— „ „ „
C. mammillata (*Thom.*).— „ „ „
C. Konincki (*Ed. and Haime*).— „ „ „
C. Newburyi (*Thom.*).— „ „ „
C. robusta (*Thom.*).— „ „ „
C. prolifera (*M'Chesney*).— „ „ „
C. Armstrongi (*Thom.*).— „ „ „
C. ejecta (*Thom.*).— „ „ „
C. granulata (*Thom.*).— „ „ „
C. cyathominuta (*Thom.*).— „ „ „
C. spiralis (*Thom.*).— „ „ „
C. reticulata (*Thom.*).— „ „ „
Axophyllum sp. ?—Brockley, Lesmahagow.
A. sp. ?—Cunningham-Baidland, Dalry.
Koninckophyllum interruptum (*Nich. and Thom.*).—Brockley, Lesmahagow.
K. Lindströmi (*Nich. and Thom.*).—Brockley, Lesmahagow.
K. retiforme (*Nich. and Thom.*).— „ „
K. sp. ?—Brockley, Lesmahagow.
Lithostrotion Portlocki (*Bron.*).—Corrieburn, Wiston, Lanarkshire.
L. junceum (*Ure*).—Brockley; Braidwood; Wiston.
L. junceum, var. **intermedium** (*Thom.*).—Asheyburn, Muirkirk.
L. simplex (*Thom.*).—Cunningham-Baidland, Dalry; Brockley, Lesmahagow.
Fasciculophyllum magnificum (*Thom.*).—Nettlehirst, Beith.
F. sp. ? (*Thom.*).—Auchenskeith, Dalry.
Diphyphyllum Argylli (*Thom.*).—In a boulder, associated with Arran granite.

Diphyphyllum concinnum (*Lons.*).—Boghead, Lesmahagow.
D. concinnum ? var. **turcatum** (*Thom.*).—Corrieburn, Campsie.
D. Blackwoodi (*Thom.*).—Kilmarnock Water, near Fenwick.
D. cylindricum (*Thom.*).—Boghead, Lesmahagow, and Roughwood, Beith.
D. latiseptum (*M'Coy*).—Corrieburn, Campsie; and Fenwick, Ayrshire.
D. gracile (*M'Coy*).—Brockley, Lesmahagow, and Roughwood.
D. giganteum (*Thom.*).—Corrieburn, Campsie.
D. interruptum (*Thom.*).—Boghead, Lesmahagow.
Lonsdaleia rugosa (*M'Coy*).—Boghead, Lesmahagow.
L. duplicata (*Martin*).—Garsewater, Muirkirk.
L. floriformis (*Fleming*).—Garsewater, Muirkirk.
Clisiophyllum Keyserlingi (*M'Coy*).—Auchenskeith, Dalry.
C. bipartitum (*M'Coy*).—Broadstone, Beith.
C. conoseptum (*Keys.*).—Langside, Beith.
C. oblongum (*Thom.*).—Roughwood, Beith.
C. M'Coyianum (*Thom.*).—Gateside, Beith.
C. Bowerbanki (*Ed. and Haime*).—Langside, Beith.
C. grandicum (*Thom.*).—Langside, Beith.
C. broadstoneianum (*Thom.*).—Broadstone, Beith.
C. Geinitzianum (*Thom.*). —Broadstone, Beith.
C. elegante (*Thom.*).— " "
C. abruptum (*Thom.*).—Gateside, Beith.
C. turbinatum (*M'Coy*).—Brockley, Lesmahagow.
C. vesicularum (*Thom.*).—Langside, Beith.
C. intermedium (*Thom.*).—Auchenskeith, Dalry.
C. subimbricatum (*Thom.*).—Broadstone, Beith.
C. irregulare (*Thom.*).—Broadstone, Beith.
C. subplicatum (*Thom.*).— " "
C. centrocellulosum (*Thom.*).—Gateside, Beith.
Aspidiophyllum Huxleyanum (*Thom.*).—Thirdpart, Beith.
A. Konincki (*Thom.*).—Thirdpart, Beith.
A. cruciforme (*Thom.*).— " "
A. Hennedyi (*Thom.*).— " "
A. elegans (*Thom.*).— " "
Dibunophyllum splendens (*Nich. and Thom.*).—Gateside, Beith.
D. Muirheadi (*Nich. and Thom.*).—Brockley, Lesmahagow.
D. M'Chesneyi (*Nich. and Thom.*).— " "
D. sp. ?—Brockley, Lesmahagow.
D. sp. ?— " "
D. sp. ?—Langside, Beith.
Rhodophyllum Slimonianum (*Thom.*).—Brockley, Lesmahagow.
R. Phillipsianum (*Thom.*).—Trearne, Beith.
R. Craigianum (*Thom.*).— " "
R. simplex (*Thom.*).—Brockley, Lesmahagow.
R. sp. ?—Langside, Beith.
R. Romeri (*Thom.*).—Langside, Beith.
R. reticulatum (*Thom.*).—Langside, Beith.
R. simplex (*Thom.*).—Brockley, Lesmahagow.
Cymatophyllum Harknessi (*Thom.*).—Thirdpart, Beith.
C. concentricum (*Thom.*).—Langside, Beith.
C. Haimeanum (*Thom.*).— " "
C. octolamellum (*Thom.*).— " "
C. Etheridgei (*Thom.*).— " "
C. Davidsoni (*Thom.*).— " "
Asymmetrilamellum Lintoni (*Thom.*).—Kilmarnock Water.
A. asheyburnense (*Thom.*).—Asheyburn, Muirkirk.
Histiophyllum Ramsayi (*Thom.*).—Brockley, Lesmahagow.

Histiophyllum beithianum (*Thom.*).—Thirdpart, Beith.
H. fasiculatum (*Thom.*).—Brockley, Lesmahagow.
H. flexuosum (*Thom.*).—Nettlehirst, Beith.
H. ellipticum (*Thom.*).—Trearne, Beith.
H. Milleri (*Thom.*).—Langside, Beith.
***Centrolamellum subcentricum** (*Thom.*).—Thirdpart, Beith.
C. bicentricum (*Thom.*).—Thirdpart, Beith.
C. hexalamellum (*Thom.*).—Brockley, Lesmahagow.
C. granulatum (*Thom.*).—Thirdpart, Beith.
C. cylindricum (*Thom.*).—Gateside, Beith.
C. quadralamellum (*Thom.*).—Langside, Beith.
C. pentalamellum (*Thom.*).— „ „
C. Mystii (*Thom.*).—Bowertrapping, Dalry.
Albertia Victoria-Regia (*Thom.*).—Langside, Beith.
A. Argylli (*Thom.*).—Langside, Beith.
A. Lindströmi (*Thom.*).— „ „
A. vesiculata (*Thom.*).— „ „
A. irregularis (*Thom.*).— „ „
A. depressa (*Thom.*).— „ „
A. intermedium (*Thom.*).—Langside, Beith.
A. Oweni (*Thom.*).— „ „
A. subconicum (*Thom.*).— „ „
Aulophyllum Patrickianum (*Thom.*).—Langside, Beith.
A. Edwardsianum (*Dun. and Thom.*).—Brockley, Lesmahagow.
A. Haimeanum (*Thom.*).—Brockley, Lesmahagow.
A. Wünschianum (*Thom.*).— „ „
Cyclophyllum fungites (*Ure*).—Shields, E. Kilbride.
C. Bowerbanki (*Ed. and Haime*).—Gameshill, Dunlop.
C. biacuminatum (*Thom.*).—Brockley, Lesmahagow.
C. obovatum (*Thom.*).—Trearne, Beith.
C. pachyendothecum (*Thom.*).—Brockley, Lesmahagow.
C. Scoulerianum (*Thom.*).— „ „
C. Duncanianum (*Thom.*).— „ „
C. ellipticum (*Thom.*).—Roughwood, Beith.
C. orbiculum (*Thom.*).—Trearne, Beith.
C. Carpenterianum (*Thom.*).—Brockley, Lesmahagow.
C. Bennieianum (*Thom.*).—Shields, E. Kilbride.
C. concentricum (*Thom.*).—Gameshill, Dunlop.
C. paradoxicum (*Thom.*).—Brockley, Lesmahagow.
C. intermedium (*Thom.*).—Nettlehirst, Beith.
C. Moseleyianum (*Thom.*).—Trearne, Beith.

The above list includes all forms of the Scottish Carboniferous Corals which have been figured and described. Some genera of the group may require to be divided or even sub-divided, and some of the species placed as varieties. More cannot be said until our knowledge of it is greater.

J. T.

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* This genus was at first named *Centrophyllum*, but I have since altered it to *Centrolamellum*, as descriptive of the fact that the lamellae only extend inwards from the inner ends of the septa to the centre of the central area.

THE CARBONIFEROUS ANNELIDA OF THE CLYDE DRAINAGE AREA.

BY (THE LATE) JOHN YOUNG, LL.D., F.G.S.

CASTS and tracks of these organisms are to be met with in both the Lower and Upper divisions of the Carboniferous rocks of the Clyde area.

Many traces of the smaller Annelids are found in the debris of the weathered limestone shales. A most interesting exposure of sandstone beds, containing abundance of the tubes or burrows of *Arenicolites,* afterwards filled with dark clay, is to be seen at Burnfield Quarry, near Thornliebank. After a period of possession the inhabitants seem to have died out, their remains having been covered up by a barren layer of shale, and this alternation has occurred some 12 or 14 times with the utmost regularity.

Arenicola, *Lamarck,* **sp.**	Burnfield Quarry, Thornliebank.
Ortonia carbonaria, *J. Young.*	Orchard, Boghead, Calderside, Brockley, Craigenglen.
Serpulites carbonarius, *M'Coy.*	Sculliongour, Langside, Beith.
S. compressus, *Gow.*	Trearne (common).
S. membranaceus, *M'Coy.*	Gare, High Blantyre (common). Craigenglen (very rare).
Spirorbis caperatus, *M'Coy.*	Brockley, Gare, on shells, crinoids, etc.
S. carbonarius, *Murch.,* **sp.**	Upper Coal-measures, on shells and plants.
S. helicteres, *Salter.*	Newton, Cambuslang.
S. spinosus, *de Kon.*	Hairmyres, Roughwood.
Vermilia minuta, *Brown.*	Gare, Robroyston, Highfield, Dalry, Capelrig, East Kilbride.

THE CARBONIFEROUS POLYZOA OF THE CLYDE DRAINAGE AREA.

BY (THE LATE) JOHN YOUNG, LL.D., F.G.S.

THE Polyzoa of the Clyde drainage area are represented by numerous genera and species which are distributed over the Lower and Upper Limestone series, and chiefly in the shales associated with the limestones proper. They may be obtained plentifully from the weathered shales in most of the localities mentioned in the following list, which has been compiled with the assistance of Dr. Young's MS. notes.

Actinostoma fenestratum, *Y. and Y.*	Hairmyres, High Blantyre.
Archaeopora nexilis, *de Kon.*	High Blantyre, Gillfoot.
Carinella cellulifera, *Eth. Jr.*	Gare, Robroyston, Orchard.
Ceriopora interporosa, *Phill.*	Gare, Brockley, High Blantyre.
C. similis, *Phill.*	Capelrig, Gare, Corrieburn.
Diastopora megastoma, *M'Coy.*	Gare, High Blantyre, Hairmyres.
Fenestella bicellulata, *Eth. Jr.*	Boghead, Hamilton.
? F. carinata, *M'Coy.*	High Blantyre, Hairmyres.
? F. crassa, *M'Coy.*	Beith Quarries.
F. ejuncida, *M'Coy.*	Newfield, Blantyre.
F. flabellata, *Phill.*	Corrieburn, Beith Quarries.
? F. formosa, *M'Coy.*	First Calmy Limestone, Carluke, Corrieburn.
F. frutex, *M'Coy.*	Corrieburn, Gillfoot.
? F. hemispherica, *M'Coy.*	Roughwood.
? F. membranacea, *Phill.*	Craigenglen, High Blantyre.
F. Morrisi, *M'Coy.*	Howrat, Corrieburn.
F. multiporata, *M'Coy.*	Roughwood, Corrieburn.
F. nodulosa, *Phill.*	Corrieburn, Beith Quarries.
F. plebeia, *M'Coy.*	High Blantyre, Hairmyres.
? F. quadridecimalis, *M'Coy.*	Gillfoot, Gare.
F. tenuiflla, *Phill.*	Gare, High Blantyre.
Fenestella tuberculo-carinata, *Eth. Jr.*	High Blantyre.
F undulata, *Phill.*	Gillfoot.
Glauconome aspera, *Y. and Y.*	Hairmyres.
G. elegans, *Y. and Y.*	Hairmyres.
G. flexicarinata, *Y. and Y.*	High Blantyre, Gillfoot.
G. laxa, *Y. and Y.*	Hairmyres.
G. marginalis, *Y. and Y.*	Hairmyres, Gillfoot.
G. retroflexa, *Y. and Y.*	Beith Quarries.
G. stellipora, *Y. and Y.*	Hairmyres, Gare.
G. stellipora, var. **spinosa**, *Y. and Y.*	Hairmyres, Gare.
G. robusta, *Y. and Y.*	?

Gonocladia cellulifera, *Eth. Jr.*	Gare, Carluke.
? **Gorgonia Lonsdaliana**, *M‘Coy.*	Auchenskeith.
Hemitrypa hibernica, *M‘Coy.*	Highfield Quarry.
Hyphasmopora Buski, *Eth. Jr.*	High Blantyre.
Polypora dendroidēs, *M‘Coy.*	Corrieburn, Beith Quarries.
? **P. papillata**, *M‘Coy.*	Auchenskeith, First Calmy Limestone, Carluke.
P. tuberculata, *Prout.*	Hairmyres, Beith Quarries.
Ptylopora pluma, *M‘Coy.*	Corrieburn.
Rhabdomeson gracile, *Phill.*	Hairmyres, Trearne.
R. rhombiferum, *Phill.*	Hairmyres, Capelrig, East Kilbride.
Sulcoretepora parallela, *Phill.*	Gare, Hairmyres, Beith.
S. raricosta, *M‘Coy.*	Corrieburn, Brockley.
S. Robertsoni, *Y. and Y.*	Trearne.
S. sp. nov., *J. Young.*	Gillfoot (Robertson Collection).
Synocladia carbonaria, *Eth. Jr.*	High Blantyre, Gillfoot.
S. Scotica, *Y. and Y.*	Gillfoot, Carluke.
Thamniscus Rankini, *Y. and Y.*	Gillfoot, Gare.
T. sp.	High Blantyre.
Vincularia Binniei, *Eth. Jr.*	Mouse Water, Wilsontown.
V. dichotoma, *M‘Coy.*	Corrieburn.

THE CARBONIFEROUS OSTRACODA OF THE CLYDE DRAINAGE AREA.

BY PROF. T. RUPERT JONES, F.R.S., AND (THE LATE) JAMES W. KIRKBY.

THE Ostracoda found in the Carboniferous strata of Western Scotland are obtained from certain fossiliferous beds in each of its chief divisions, viz. the Calciferous Sandstone series, the Lower Limestone series, the Middle Coal and Ironstone series, the Upper Limestone series, and the Upper Coal and Ironstone series. The division, however, which has yielded the greatest number of genera and species is the Lower Limestone and its accompanying shales, chiefly of marine origin. In the strata, believed to be of lacustrine or freshwater origin from their fossil evidence, and from the absence of characteristic marine remains, as in the case of those strata which compose the Lower and Upper divisions of the Coal and Ironstone series, there are found certain forms of a small group of Ostracoda highly characteristic of these so-termed lacustrine conditions, and some of the species of which are found to range in time from the lower to the higher beds. The Ostracoda, wherever they appear, have evidently been very abundant in the waters in which these strata were being deposited, as their minute shells are often seen to have largely contributed to the formation of the beds. As a general rule they are hardly ever found mingling with the characteristic marine forms, which shows that the conditions under which the two groups lived were different.

The species of the group have been, so far as discovered, very fully determined, described, and figured, thanks to the long-continued labours of Prof. T. Rupert Jones, F.R.S., and Mr. James W. Kirkby,[1] who have made its study one of their chief specialities, culminating in the publication of their Monograph on the Carboniferous Ostracoda issued by the Palaeontographical Society in 1874 and 1884. Extracted from a paper by the late Dr. John Young, F.G.S., read before the Geological Society of Glasgow in 1891.[2]

Other important memoirs by Prof. Jones and Mr. Kirkby with figures and descriptions of the same subject have been published in the following:

Annals and Magazine of Natural History, 1865, 1866, 1875, 1879, 1885, 1886, 1892, and 1895.

Transactions of the Geological Society of Glasgow, 1869.

Quarterly Journal of the Geological Society, 1879.

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[1] A few weeks before this article was put in type the regretted death of Mr. Kirkby occurred. Consequently the list has not had the benefit of his supervision.

[2] "Notes on the group of Carboniferous Ostracoda found in the strata of Western Scotland, with a revised list of Genera and Species." By John Young, F.G.S., *V.P. Trans. Geol. Soc. of Glasgow*, vol. ix., part 2, 1893, p. 301.

Proceedings of the Geologists' Association, 1886.
Geological Magazine, 1886.
Transactions of the Manchester Geological Society, 1890.
Transactions of the Royal Dublin Society, 1896.
Canadian Record of Science, 1897.
Transactions of the Edinburgh Geological Society, 1899.

Cypridina brevimentum, *Jones and Kirkby*.—(*Fide* J. Young.)
C. **Hunteriana**, *J. and K.*—Braidwood.
C. **oblonga**, *J. and K.*—Trearne.
C. **Phillipsiana**, *Jones*.—Braidwood, Glencartholm.
C. **primaeva** (*M'Coy*).—Brockley.
C. **radiata**, *J. and K.*—Airdrie.
C. **scoriacea**, *J. and K.*—Gare.
C. **Grossartiana**, *J. and K.*—Bathgate.
C. **Thomsoniana**, *J. and K.*—Gare.
C. **Youngiana**, *J. and K.*—Gare.
Cypridella Edwardsiana, *de Kon.*—Bathgate.
C. **Edwardsiana**, var. **septentrionalis**, *J. and K.*—Trearne.
C. **Koninckiana**, *Jones*.—(Robertson Collection.)
C. **obsoleta**, *J. and K.*—(Robertson Coll.).
C. **Wrighti**, *J. and K.*—(Robertson Coll.).
Cypridinella Cummingi, *J. and K.*—Trearne.
C. **superciliosa**, *J. and K.*—Trearne, Bathgate, Beith.
C. **vomer**, *J. and K.*—(*Fide* J. Young.)
Cypridellina intermedia, *J. and K.*—Bathgate.
C. **Burrovi**, *J. and K.*—Near Beith (Robertson Coll.).
Cyprella annulata, *de Kon.*—Bathgate.
C. **chrysalidea**, *de Kon.*, var. **subannulata**, *J. and K.*—Bathgate.
Bradycinctus Rankinianus, *J. and K.*—Gare.
Entomoconchus Scouleri, *M'Coy*.—(Small.) Beith (Robertson Coll.).
E. **globosus**, *J. and K.*—Broadstone.
Polycope simplex, *J. and K.*—Braidwood.
P. **Youngiana**, *J. and K.*—South Hill, Campsie.
Entomis biconcentrica, *Jones*.—Carluke.
Cytherella attenuata ? *J. and K.*—Glencartholm.
C. **Benniei**, *J. and K.*—Williamwood.
C. **brevis**, *Jones*.—Campsie, Carluke.
C. **concinna**, *J., K. and Brady*.—East Kilbride.
C. **elongata** ? *J. and K.*—Bathgate.
C. **aequalis**, *J., K. and B.*—Gare.
C. **inflata** (*Münster*).—Campsie.
C. **obesa**, *J., K. and B.*—West Broadstone.
C. **obliquata**, *J., K. and B.*—Craigenglen, Capelrig Quarry, E. Kilbride.
C. **recta**, *J., K. and B.*—Gare, Auchenbeg.
C. **reticulosa**, *J. and K.*—Robroyston.
C. **rotundata**, *J. and K.*—Burnbank, Carluke (Robertson Coll.).
C. **scrobiculata**.—Williamwood, Orchard.
C. **simplex**, *J. and K.*—Raes Gill, Carluke.
C. **valida**, *J. and K.*—Glencartholm, Gilnockie Tower.
Leperditia acuta, *J. and K.*—Craigie.
L. **Armstrongiana**, *J. and K.*—Brockley, Howrat.
L. **Bosquetiana**, *J. and K.*—Tirfergus Glen.
L. **compressa**, *J. and K.*—Craigenglen.
L. **Lovicensis**, *J. and K.*—Braehead, Craigie.
L. **oblonga**, *J. and K.*—East Kilbride.
L. **Okeni** (*Mün.*).—Brockley, Williamwood, Thornton.

Leperditia parallela ? *J. and K.*—Glencartholm.
L. scotoburdigalensis (*Hibbert*).—Glencartholm.
L. suborbiculata (*Mün.*).—Craigie, Thornton.
L. subrecta (*Portlock*).—Glencartholm.
L. Youngiana, *J. and K.*—Dalry.
Beyrichia arcuata (*Bean*).—Shotts, Carluke.
B. bicaesa, *J. and K.*—Woodhill.
B. Bradyana, *J. and K.*—Boghead, High Blantyre.
B. cratigera, *Brady.*—Glencartholm, Calderside.
B. fastigiata, *J. and K.*—Craigenglen, Bathgate.
B. fodicata, *J. and K.*—Linlithgow Bridge.
B. gigantea, *J. and K.*—Glencartholm, Carluke.
B. intermedia, *Jones and Holl.*—Dernshaw.
B. multiloba, *Jones.*—Boghead, Craigenglen.
B. radiata, *J. and K.*—Orchard, Robroyston.
Beyrichiella Youngiana, *J. and K.* (MS.).—Glencartholm.
B. reticosa, *J. and K.*—Glencartholm, Whitebaulks.
B. ventricornis, *J. and K.*—Brockley, Gair.
Beyrichiopsis cornuta, *J. and K.*—Linlithgow Bridge.
B. fimbriata, *J. and K.*—Glencartholm.
B. fortis, *J. and K.*—Glencartholm.
Ulrichia bituberculata, *J. and K.*—Orchard, East Kilbride.
U. tuberculospinosa, *J. and K.*—Williamwood, Stacklawhall.
Kirkbya costata (*M'Coy*).—Gilnockie Tower, Glencartholm.
K. oblonga, *J. and K.*—Brockley, Williamwood.
K. permiana, *Jones.*—Orchard, Robroyston.
K. plicata, *J. and K.*—Campbeltown.
K. rigida, *J. and K.*—Orchard, Williamwood.
K. Robertsoniana, *J. and K.* (MS.).—Derushaw.
K. scotica, *J. and. K.*—Campbeltown, Linlithgow Bridge.
K. spinosa, *J. and K.*—Craigenglen, Capelrig, East Kilbride.
K. spiralis, *J. and K.*—Glencartholm, Oakbank.
K. tricollina ? *J. and K.*—Orchard.
K. umbonata (*Eichw.*).—Brockley, Hairmyres.
K. Urei, *Jones.*—Craigenglen, Brockley.
Synaphe annectens, *J. and K.*—Craigenglen, Orchard.
Carbonia Bairdioides, *J. and K.*—Craigenglen.
C. fabulina, *J. and K.*—Whifflet, Shotts Ironworks, Thornton.
C. pungens, *J. and K.*—Provanhall, Carluke.
C. Rankiniana, *J. and K.*—Provanhall, Airdrie.
C. secans, *J. and K.*—Craigenglen.
C. subula, *J. and K.*—Craigenglen.
Bythocypris bilobata (*Mün.*).—Broadstone, Braidwood.
B. cuneola, *J. and K.*—Robroyston, Orchard.
B. cornigera, *J. and K.*—Robroyston, Gare.
B. Phillipsiana, *Jones and Holl*, var. **carbonica**.—East Kilbride.
B. Robertsoniana, *J. and K.* (MS.).—Braehead.
B. sublunata, *J. and K.*—Glencartholm.
B. pyrula, *J. and K.*—Braehead.
Argilloecia aequalis, *J. and K.*—Glencartholm, Heads of Ayr.
Aglaia cypridiformis, *J. and K.*—Glencartholm.
Macrocypris Jonesiana, *Kirkby.*—Craigenglen.
M. carbonica, *Brady.*—Campsie.
Bairdia ampla, *Reuss.*—Hairmyres, Stacklawhall.
B. amputata, *Kirkby.*—Brockley, Gilnockie Tower.
B. brevis, *J. and K.*—Brockley, Craigenglen.
B. curta, *M'Coy.*—Kennox Water, Braidwood.

Bairdia grandis, *J. and K.*—Carluke.
B. Hisingeri (*Mün.*).—Brockley, Stacklawhall.
B. legumen ? *J. and K.*—Craigenglen.
B. siliquoides, *J. and K.*—Kennox Water, Glencartholm.
B. subelongata, *J. and K.*—Brockley, Craigenglen.
B. subcylindrica (*Mün.*).—Carluke, Gillfoot.
B. submucronata, *J. and K.*—Gare, Carluke, Orchard.
B. plebeia, *Reuss.*—Orchard, Craigenglen.
Cythere ? superba, *J. and K.*—Heads of Ayr.
C. intermedia, *J. and K.*—Carluke.
Bythocythere Youngiana, *J. and K.*—Brockley, Craigenglen.
Youngiella rectidorsalis, *J. and K.*—Dernshaw, Orchard.
Y. sp. nov. ? Williamwood, Westerhouse.
Xestoleberis subcarbuloides ? *J. and K.*—Shields.
Darwinula ? Berniciana ? *Jones.*—Robroyston, East Kilbride.

PHYLLOPODA.

Estheria striata (*Mün.*).—Lanarkshire.
E. tenella, *Jordan.*—Airdrie, Carluke, Lanarkshire.
E. Youngi, *Jones.*—Arden, Thornliebank.
E. tessellata, *Jones.*—Airdrie ?
E. tegulata, *Jones.*—Airdrie ?

PHYLLOCARIDA.

Dithyrocaris glabra, *Woodw. and Ether.*—Ardrossan, East Kilbride.
D. granulata, *W. and E.*—East Kilbride.
D. insignis, *J. and W.*—East Kilbride.
D. Neilsoni, *J. and W.*—East Kilbride.
D. ovalis, *W. and E.*—East Kilbride.
D. testudinea, *Scouler.*—Paisley, Ardrossan, East Kilbride, Carluke.
D. tricornis, *Scouler.*—Paisley, East Kilbride.
Calyptocaris striata, *Woodw.*—Carmichael Burn, Lanarkshire.
Chaenocaris Youngi, *J. and W.*—Robroyston.
Lebescontia occulta, *J. and W.*—Dalry.

THE CARBONIFEROUS BRACHIOPODA OF THE CLYDE DRAINAGE AREA.

BY JAMES NEILSON.

THE important group of Brachiopods is well represented in the marine beds of the Upper and Lower Limestone series of the Clyde drainage area, especially in the Lower Limestones, and the most finely preserved examples are found in the associated shale-beds, showing in many cases the interior structure and muscular impressions. The minute organisms have been obtained in great abundance from the rotted limestone of the upper part of the Lower Limestones near Beith in Ayrshire.

The Middle Coal and Ironstone series, which lies between the above-mentioned marine beds, and is chiefly of freshwater origin, is not known to contain any brachiopods except a few specimens of *Lingula mytiloides* and *L. squamiformis*, which occur in the alternating brackish-water beds.

The Calciferous Sandstone series of the Clyde drainage area does not yield any brachiopods, several species previously recorded from Arran being now found to belong to the Upper and Lower Limestones.

The boundaries of the Millstone Grit series are not as yet well-defined, and the fossils recorded from it appear so low down in the beds, abutting on the Upper Limestones, that it has been thought best to include them in the list from that series.

The remains of brachiopods, chiefly as casts, are found in a bed of hard, white sandstone, exposed in a cutting on the North British Railway just south of Garngad Station, Glasgow, and this is, so far as we know, the only instance of the remains of marine mollusca having been met with in sandstone belonging to the Western Scottish coal-field.

One or two forms of brachiopods, *e.g. Lingula*, range upwards into the lower strata of the Upper Carboniferous series, but are confined to thin bands which do not contain any of its more characteristic forms.

In 1865 a thin bed containing two species of brachiopods and some other marine forms was discovered in the sinking of a coal-pit at Drumpark, about 200 fathoms above the Millstone Grit, but no similar occurrence has since been noted.[1]

The arrangement adopted in the following list is that of the late Dr. Thomas Davidson in his Monograph of "The British Carboniferous Brachiopoda" issued by the Palaeontographical Society. The divisions of the rocks in which the fossils occur are given before the localities in heavy letters.

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[1] *Trans. Geol. Soc. of Glasgow*, vol. ii., 1865, p. 52.

TRETENTERATA.

Lingula mytiloides, *Sow.*—**U. C. S.** Alexandra Parade, near Craigpark Street: Drumbeg, Annbank. Slatyband Ironstone. Benhar: and Shotts. **U. L. S.** Gare: Robroyston: Orchard: Thornliebank. **M. I. S.** Possil: Cadder: Beith: Dalry. **L. L. S.** Calderwood series: Kilbride: High Blantyre: Boghead: Craigenglen: Beith.

L. squamiformis, *Phill.*—Not in **U. C. S.** but generally in same locs. as above.

L. scotica, *Dav.*—(very rare). **U. L. S.** Gare: Robroyston: Limekilnburn: Gillfoot, Carluke. **M. I. S.** Hall Hill, Lesmahagow. **L. L. S.** Boghead, Hamilton.

L. (?) Thomsoni, *Dav.*—(very rare). **L. L. S** Tirfergus Glen, Campbeltown.

Discina nitida, *Phill.*—**U. C. S.** Drumpark Pit. Baillieston (Skipsey). Shotts. Slatyband Ironstone. **U. L. S.** Same beds as *L. mytiloides*. **L. L. S.** Same beds as *L. mytiloides*. Appears to be absent in **M. I. S.**

D. Craigi, *Dav.*—**U. L. S.** N.B. Ry. cutting S. of Garngad Road, Glasgow. **L. L. S.** Trearne, Beith.

Crania quadrata, *M'Coy.*—**U. L. S.** Gare: Orchard: Thornliebank. **L. L. S.** Calderside limestone shale (common and fine), E. Kilbride: High Blantyre: Boghead.

CLISTENTERATA.

Dielasma (Terebratula) sacculus, *Martin.*—**L. L. S.** Beith: Dalry: Corrieburn: Braidwood.

D. (T.) sacculus, var. **hastata**, *Sow.*—Found along with above.

D. (T.) sacculus, var. **vesicularis**, *de Kon.*—**U. L. S.** Bowertrapping: Arden: Linn Spout. **L. L. S.** Braidwood: Beith.

D. (T.) sacculus, var. **Gillingensis**, *Dav.*—**L. L. S.** Craigenglen: Corrieburn: Cunningham-Baidland, Dalry.

Spirifera duplicicosta, *Phill.*—(rare). **L. L. S.** Beith Quarries: Brockley: Braidwood: Balgrochan Burn, and Main Limestone, Campsie.

S. triangularis? *Martin.*—**L. L. S.** Carluke (Rankin).

S. trigonalis, *Martin* (and var. **bisulcata**, *Sow*).—**U. L. S.** Orchard: Williamwood: Thornliebank: Arden: Bowertrapping: Saltpans, Arran. **L. L. S.** Bathgate: High Blantyre: East Kilbride: Craigenglen, and Main Limestone, Campsie: Corrieburn: Beith and Dalry: Gameshill, Dunlop: Corrie.

S. ovalis, *Phill.*—**L. L. S.** Brockley: Corrieburn: Beith.

S. triradialis, *Phill.*—**L. L. S.** Dockra, and Waterland, Beith: Cunningham-Baidland, Dalry: Brockley.

Martinia (Spirifera) glabra, *Martin.*—**U. L. S.** Orchard: Arden: Thornliebank. **L. L. S.** Beith and Dalry Quarries: Corrieburn: Main Limestone, Campsie: Thornton.

M. Urei, *Fleming.*—**U. L. S.** Orchard: Bowertrapping: Gare. **L. L. S.** South Hill, Craigenglen: Main Limestone, Campsie: Thornton: Brockley: Braidwood: Dockra, Beith.

M. carlukensis, *Dav.*—**U. L. S.** Gillfoot. **L. L. S.** Brockley: Dockra and Trearne, Beith.

Reticularia (Spirifera) lineata, *Martin.*—**U. L. S.** Arden: Thornliebank: Orchard: Gare: Robroyston. **L. L. S.** Beith Quarries: Braidwood: Lesmahagow: Corrieburn: Main Limestone, Campsie: High Blantyre: E. Kilbride.

Spiriferina cristata, var. **octoplicata**, *Sow.*—**U. L. S.** Gare: Orchard. **L. L. S.** Boghead: High Blantyre: E. Kilbride: Carluke: Trearne and Dockra, Beith: Corrieburn.

Spiriferina insculpta, *Phill.*—(very rare). **U. L. S.** Gare: Gillfoot: Muirkirk: Saltpans, Arran.

S. laminosa, *M'Coy*—(very rare). **U. L. S.** Gillfoot, near Carluke; Saltpans, Arran (common). **L. L. S.** Auchenskeith: Brockley.

Athyris ambigua, *Sow.*—**U. L. S.** Gare: Orchard: Arden: Hillerhirst: Saltpans, Arran. **L. L. S.** Braidwood: Corrieburn: Craigenglen: Beith: Netherwood, Strathavon.

A. plano-sulcata, *Phill.*—**L. L. S.** Brockley: Braidwood: Corrieburn: Beith and Dalry.

A. Royssi, *Leveillé*.—**L. L. S.** Braidwood: Corrieburn: Beith and Dalry.

A. pisum, *Dav.*—(very rare). **L. L. S.** Brockley.

Retzia radialis, *Phill.*—(rare). **U. L. S.** Gare: Limekilnburn. **L. L. S.** Brockley: Dockra and Trearne, Beith: Braidwood: Corrieburn: Laggan, Arran.

Rhynchonella pugnus, *Martin.*—**U. L. S.** Gare: Robroyston: Castlecary: Arden: Bowertrapping. **L. L. S.** Corrieburn: High Blantyre: E. Kilbride: Braidwood: Beith.

R. pleurodon, *Phill.*—**L. L. S.** Corrieburn: Craigenglen: High Blantyre: E. Kilbride: Braidwood: Beith: Corrie and Laggan, Arran.

S. brockleyensis, *Dav.*—(very rare). **L. L. S.** Brockley.

Rhynchopora Youngi, *Dav.*—(very rare). **U. L. S.** Bowertrapping; Dalry.

Camarophoria crumena, *Martin.*—(very rare). **L. L. S.** Main Limestone, Campsie.

C. globulina, *Phill.*—(very rare). **L. L. S.** Brockley: Braidwood: Auchenskeith: Broadstone, Beith.

Strophomena rhomboidalis, *Phill.*, var. **analoga,** *Phill.*—(very rare). **L. L. S.** Corrieburn: Main Limestone, Campsie: Laugside, Beith.

S. rhomboidalis, var. **distorta.** **U. L. S.** Gare: Limekilnburn: Browntod: Bowertrapping.

Streptorhynchus crenistria, *Phill.* (and var. **radialis**). **U. L. S.** Gare: Orchard: Thornliebank: Linn Spout, Dalry: Garngad Rd., Glasgow. **L. L. S.** Corrieburn: Main Limestone, Campsie: Braidwood: Beith: Auchenskeith: Laggan, Arran.

S. crenistria, var. **senilis,** *Phill.*—(very rare). **U. L. S.** Bowertrapping.

S. crenistria, var. **cylindrica (robusta),** *M'Coy.* **U. L. S.** Tirfergus Glen, Campbeltown: Garngad Road, Glasgow: Muirkirk.

Orthis Michelini, *Leveillé.*—**L. L. S.** Beith Quarries: Braidwood: Corrieburn: Main Limestone, Campsie.

O. resupinata, *Martin.*—**U. L. S.** Gare: Robroyston: Castlecary: Thornliebank: Orchard: Garngad Road. **L. L. S.** Corrieburn: Craigenglen: Carluke: Beith: Laggan, Arran.

Chonetes Laguessiana, *de Kon.*—**U. L. S.** Gare: Orchard: Thornliebank. **L. L. S.** E. Kilbride: High Blantyre: Boghead: Thornton: Beith: Campsie.

C. Laguessiana, var. **gibberula,** *M'Coy*—(very rare). **L. L. S.** Corrieburn: Dockra, Beith.

C. Buchiana, *de Kon.*—(very rare). **U. L. S.** Gare: Swindridge, Beith. **L. L. S.** Millburn, Campsie: Braidwood.

C. polita.—**U. L. S.** Gillfoot, Braidwood. **L. L. S.** Craigenglen: Thornton: Braidwood.

Productus giganteus, *Martin.*—**U. L. S.** Bowertrapping: Arden: Orchard. **L. L. S.** Braidwood: Muirkirk: Shields, E. Kilbride: Thornton: Lesmahagow (largest specimens): Corrieburn and Millburn, Campsie: Corrie, Laggan, Maoldon, etc., Arran.

P. latissimus, *Sow.*—**U. L. S.** Bowertrapping: Muirkirk: Auldhouse, E. Kilbride: Saltpans, Arran. **L. L. S.** Craigenglen.

P. cora, *d'Orb.*—**U. L. S.** Arden: Bowertrapping. **L. L. S.** Boghead, Hamilton: Braidwood: Campsie: Dockra, Beith.

Productus semireticulatus, *Martin* (and vars. **P. Martini**, *Sow*, **P. concinnus**, *Sow*, and **P. scoticus**, *Sow*).—Generally distributed through Marine Limestones and Shales of **U. L. S.** and **L. L. S.**

P. costatus, *Sow.*—**U. L. S.** Orchard: Thornliebank. **L. L. S.** Braidwood: Main Limestone, Campsie: Gameshill, Dunlop.

P. costatus, var. **muricatus**, *Phill.*—**U. L. S.** Ry. cutting, Garngad Rd., in Sandstone: Thornliebank. **L. L. S.** Corrieburn: Beith Quarries.

P. scabriculus, *Martin.*—**U. C. S.** Drumpark Colliery. **U. L. S.** Garngad Rd.: Garnkirk: Castlecary: Arden. **L. L. S.** Carluke: Brockley: Beith: Craigenglen: Corrieburn.

P. pustulosus (?) *Phill.*—**L. L. S.** Braehead, Busby: Langside, Beith: Braidwood.

P. carbonarius, *de Kon.*—**U. L. S.** Shale over Cement, Garngad Rd., N.B.Ry. Station.

P. longispinus, *Sow.*—Generally distributed through the marine Limestones and Shales of **U. L. S.** and **L. L. S.**

P. Griffithianus, *de Kon.*—**L. L. S.** Brockley: Dockra, Beith.

P. sinuatus, *de Kon.*—**U. L. S.** Garngad Rd.: George Square, Glasgow: Arden: Bowertrapping. **L. L. S.** Braidwood.

P. fimbriatus, *Sow.*—**L. L. S.** Beith Quarries: E. Kilbride: Main Limestone, Campsie.

P. aculeatus, *Mart.*—**L. L. S.** Cunningham - Baidland: Braidwood: Brockley: Main Limestone, Campsie.

P. Youngianus, *Dav.*—**U. L. S.** Orchard (very rare). **L. L. S.** Corrieburn: Beith: Cunningham-Baidland: E. Kilbride: Laggan, Arran.

P. punctatus, *Mart.* (and var. **elegans**), *M'Coy.*—**U. L. S.** Castlecary: Arden: Bowertrapping. **L. L. S.** Craigenglen: Corrieburn: Beith: Dalry: Braidwood.

P. undatus, *Def.*—(very rare). **U. L. S.** Castlecary: Gare: Arden. **L. L. S.** Millburn and Glorat, Campsie: Carluke: Braidwood.

P. mesolobus, *Phill.*—(very rare). **U. L. S.** Arden. **L. L. S.** Main Limestone, Campsie: Braidwood.

P. spinulosus, *Sow.*—**L. L. S.** Brockley: Beith: Cunningham-Baidland: Corrieburn.

P. Deshayesianus, *de Kon.*—**L. L. S.** Main Limestone, Braidwood.

THE CARBONIFEROUS LAMELLIBRANCHIATA OF THE CLYDE DRAINAGE AREA.

BY JAMES NEILSON.

THIS class of the mollusca ranges throughout the several divisions of the Carboniferous rocks, the marine species being met with in the greatest numbers in the shales and clay-ironstones alternating with the limestones, in which latter, however, comparatively few specimens are found.

The freshwater, or brackish-water group, represented by the *Carbonicola*, *Anthracomya*, and *Naiadites*, are confined chiefly to the musselband ironstones and shales of the Upper Carboniferous series, a few species being got in similar strata in the Middle Coal and Ironstone series, while one—*Naiadites crassa*—is found in shale under the lowest limestone in the Beith district, associated with marine fossils. None of this group are to be met with in any of the beds yielding the characteristic marine organisms of the system, while, on the other hand, none of the latter are found in the Middle Coals and Ironstones. In several instances where *Carbonicola* is said to have been got along with marine organisms it may probably have been derived from some earlier deposit, or drifted seawards from its own proper habitat, or even more probably, it may have been picked up on a shale-heap amongst marine fossils, having really been derived from quite a different stratum, as recently happened in the case of other fossils at Alexandra Parade, Glasgow. It is evident that these freshwater or brackish-water forms have lived in the Scottish coal-field under quite different conditions from the marine ones found in the Limestone series.

In the following list the names of the freshwater group are those given in Dr. Wheelton Hind's Monograph on *Carbonicola*, *Anthracomya*, and *Naiadites*, and those of the marine *Dimyaria* in his Monograph on the Carboniferous Lamellibranchiata, both issued by the Palaeontographical Society, 1894 to 1900. Unfortunately Dr. Hind has not yet worked out the *Monomyaria*, though it is to be hoped he will soon do so, as at present the group is in a most unsatisfactory condition. When this is done we are under the impression that the number of species will be very much reduced.

Many of the generic and specific names in this list will be found to differ from those in the 1876 Catalogue[1] owing to various causes, such as the sub-division of genera, the former names being synonyms of previously-existing species, or former faulty identification of the species. For facility of reference to the existing literature on the subject the old names have been given in *italics*, and within brackets ( ).

MONOMYARIA.

Leiopteria lunulata, *Phill.*—(rare). **U. L. S.** Gare : Thornliebank. **L. L. S.** Howrat, Dalry.

L. squamosa. **U. L. S.** Thornliebank : Garpel Water, Muirkirk.

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[1] *Catalogue of the Western Scottish Fossils*, Glasgow, 1876.

Avicula ? concinna, *M'Coy.*—**U. L. S.** Shale over Linn Limestone, Dalry.

A. ? decussata, *M'Coy.*—**U. L. S.** Along with above.

A. ? prisca, *M Coy.*—**L. L. S.** Lingula Ironstone, Carluke; Hairmyres, E. Kilbride.

A. subanisotus, *R. Ether. jun.*—**L. L. S.** Glenwhapple Burn, near Craigenglen.

Aviculopecten arenosus, *Phill.*—**L. L. S.** Carluke; Campsie (Main Limestone), High Blantyre; Thornton.

A. caelatus, *M'Coy.*—**U. L. S.** Orchard; Linn, Dalry; Garngad Road. **L. L. S.** Beith Quarries.

A. clathratus, *M'Coy.*—**L. L. S.** Boghead, Hamilton.

A. cognatus, *M'Coy.*—(Rare). **L. L. S.** Main Limestone, Braidwood.

A. concavus, *M'Coy.*—**L. L. S.** Boghead, Lesmahagow.

A. concentricostriatus, *M'Coy.*—(Rare). **L. L. S.** Corrieburn.

A. consimilis, *M'Coy.*—(Rare). **U. L. S.** Bowertrapping. **L. L. S.** Craigenglen.

A dissimilis, *Flem.*—(Rare). **L. L. S.** Boghead, Hamilton; Main Limestone, Carluke.

A. docens, *M'Coy.*—(Very Rare). **L. L. S.** East Kilbride.

A. Dumontianus, *de Kon.*—**U. L. S.** Garngad Road; Bowertrapping. **L. L. S.** Trearne; Main Limestone, Braidwood.

A. duplicicosta, *M'Coy.*—(Rare). **L. L. S.** Boghead, Hamilton; Lingula Ironstone, Carluke.

A. elongatus, *M'Coy.* **L. L. S.** Roughwood, Beith.

A. fallax, *M'Coy.*—**L. L. S.** Lingula Ironstone, Carluke.

A. fimbriatus, *M'Coy.*—(Common). **L. L. S.** Newfield; Boghead, Hamilton; Brockley; Carluke; Corrieburn; Beith; Cunningham-Baidland.

A. flexuosus, *M'Coy.*—**L. L. S.** Hillhead, Beith.

A. granosus, *Sow.*—**U. L. S.** Garngad Road. **L. L. S.** Corrieburn.

A. incrassatus, *M'Coy.*—**L. L. S.** Auchenskeith.

A. interstitialis, *Phill.*—**U. L. S.** Gare; Bowertrapping. **L. L. S.** Craigenglen; Corrieburn.

A. Knockonniensis, *M'Coy.*—**L. L. S.** Brockley: Boghead, Hamilton.

A. macropteris, *M'Coy.*—**L. L. S.** First Calmy Limestone, Carluke.

A. ornatus, *R. Ether., jun.*—**L. L. S.** Calderwood Cement Shales; Main Limestone, Carluke.

A. oryza, *R. Ether., jun.*—**L. L. S.** Second Kingshaw Limestone, Carluke.

A. ovatus, *M Coy.*—**U. L. S.** Linn Limestone, Dalry.

A. papyraceus, *Goldf.*—**M. I. S.** Inkerman, Paisley. **L. L. S.** Shale over Cement, E. Kilbride. (In England this shell is considered characteristic of Upper Carboniferous strata.)

A. planoradiatus, *M'Coy.*—**L. L. S.** Boghead; Lesmahagow.

A. plicatus, *Sow.*—(Rare). **U. L. S.** Gare. **L. L. S.** Main Limestone, Carluke; Clay Ironstone, Craigenglen.

A. scalaris, *Sow.*—(Very Rare). **U. L. S.** Gare.

A. sclerotis, *M'Coy.*—(Very Rare). **L. L. S.** Boghead, Hamilton; Craigenglen; Main Limestone, Braidwood.

A. semicircularis, *M'Coy.*—**L. L. S.** Roughwood; Thornton, in Shale under Main Limestone.

A. semistriatus, *M'Coy.*—**L. L. S.** East Burn, Stewarton.

A. serratus, *M'Coy.*—**L. L. S.** Newfield; Howrat.

A. simplex, *de Kon.*—**U. L. S.** Gare; Orchard. **L. L. S.** Boghead, Hamilton; Capelrig; Cunningham-Baidland.

A. subelongatus, *M'Coy.*—**U. L. S.** Bowertrapping. **L. L. S.** Craigenglen.

A. stellaris, *Phill.*—**L. L. S.** Corrieburn; Main Limestone, Braidwood.

A. tessellatus, *Phill.*—**U. L. S.** Gare. **L. L. S.** Lingula Ironstone, Carluke.

Entolium (Pecten) Sowerbyi, *M'Coy.*—**L. L. S.** High Blantyre; Boghead, Hamilton; Thornton, in Shale under Main Limestone.

Pinna flabelliformis, *Mart.* (including *P. flexicostata.*)—**U. L. S.** Bishopbriggs; Arden. **L. L. S.** Beith; Craigie; Brockley.

P. mutica, *M'Coy.*—(*P. Ivanskiana* and *P. spatula*). **L. L. S.** Inkerman Paisley; Lingula Ironstone, Carluke; High Blantyre; Craigenglen.

Pteronites latus, *M'Coy.*—(Very Rare). **L. L. S.** Corrieburn; Cunningham-Baidland.

Actinopteria (Pteronites) fluctuosa, *M'Coy.*—**L. L. S.** Abundant in thin band of Shale. Craigenglen.

A. persulcatus, *M'Coy.*—**U. L. S.** Linn Spout. **L. L. S.** Craigenglen; Corrieburn; Kilbride; Waterland; Beith.

Posidonomya? (Anomia) corrugata, *R. Ether. jun.*—**U. L. S.** Linn Spout. **L. L. S.** Boghead; East Kilbride (in Cement-shales); Thornton (under Main Limestone); Craigie.

P.? (Estheria) punctatella, *Jones.*—**U. L. S.** Linn Spout; Arden.

DIMYARIA.

(*Freshwater Shells.*)

Unless where marked otherwise these localities are all Upper Carboniferous.

Carbonicola (Anthracosia) robusta, *Sow.*—(Note.—This species is not found higher than the roof of the Drumgray coal). **U. C.**—Carluke; Shotts; Slamannan; Dalmellington; Alexandra Parade, Glasgow. **M. I. S.** Dalry.

C. acuta, *Sow.*—Shales of the Drumgray coal and upwards. Kilmarnock; Shotts; Airdrie; Shettleston; Carluke. Slatyband Ironstone, Stonehouse and Douglas (Survey). **L. L. S.** Raes Gill Ironstone, Carluke (Geol. Survey, sheet 23).

C. ovalis, *Martin.*—Virtuewell coal, Shotts; Airdrie, Blackland Ironstone. Bellside Ironstone, Carluke, Carmyle and Kenmuir.

C. polmontensis, *Brown.*—Coal shale, Polmont, nr. Falkirk; Springhill Colliery, nr. Kilmarnock; Kirkwood Colliery, Old Monkland; Ell Coal, Kilwinning.

C. turgida, *Brown.*—Dalmellington; Lugar; Wishaw; Cambuslang; Shettleston.

C. aquilina, *Sow.*—(*Unio or Anthracosia l rei, Flem.*). Ell to Splint Coal. Rutherglen; Cambuslang; Shettleston; Motherwell; Fullarton, Ayrshire. Alexandra Parade, Glasgow. Slatyband Ironstone, Douglas. Enters largely into the composition of Musselband Ironstone.

C. similis, *Brown.*—Lugar: Springburn Colliery, Ayrshire.

Anthracomya modiolaris, *Sow.*—Ell to Drumgray coal, Airdrie; Motherwell; Shettleston; Carluke; Kilmarnock; Old Cumnock.

A. Williamsoni, *Brown.*—Eastfield, Rutherglen.

A. minima, *Ludwig.*—**M. I. S.** Possil, Glasgow.

A. Phillipsi, *Williamson.*—Palacecraig Ironstone, Airdrie.

A. Wardi, *Salter.*—**M. I. S.** Possil Lower Ironstone.

Naiadites (Anthracoptera) modiolaris, *Sow.*—Kilwinning: Splint Coal, Shettleston to Rutherglen, Shotts, from Kiltongue to Gas Coal.

N. triangularis, *Sow.*—Shotts.

N. carinata, *Sow.*—Shettleston; Carmyle; Old Monkland; Shotts.

N. quadrata, *Sow.*—Splint Coal, Shotts.

N. (Myalina) crassa, *Flem.*—**L. L. S.** Lugton Water, nr. Dunlop; Roughwood and Lyonshields, Beith.

(Note.—This species is found associated with marine forms.)

Naiadites magna, *Hind.*—Middle Ironstone and Coal Series. Blackband Ironstone, Bankend, Lesmahagow.

(*Marine Shells.*)

Modiola megaloba, *M'Coy.*—**L. L. S.** Craigenglen. (NOTE.—Dr. Hind now believes this to be a young or dwarfed condition of *Naiadites crassa.*)

? M. (Lithodomus) Jenkinsoni, *M'Coy*—Lingula Ironstone, Carluke.

Lithodomus lingualis, *Phill.*—(Very Rare.) **L. L. S.** Craigenglen; Broadstone, Beith; E. Kilbride; Lingula Ironstone, Carluke.

L. lithodomoides, *R. Ether., jun.*—**L. L. S.** Shale under Lower Limestone, Beith; Glen Lora and Lochwinnoch, Renfrewshire; Corrieburn; Craigie, near Kilmarnock. (*Very local and gregarious.*)

Posidoniella vetusta, *Sow.*—**U. L. S.** Castlecary; Burn Anne (opposite Cessnock Castle); Galston.

Myalina Flemingi, *M'Coy.*—**U. L. S.** Shale and Sandstone in ry. cutting, Garngad Road. **L. L. S.** Thin band of Ironstone on shore S. of landing-place, Corrie, Arran.

M. Verneuili, *M'Coy.*—**U. L. S.**—Garngad Road (as above), Auchenbeg and Bankend, Lesmahagow. **M. I. S.** Inkerman, Paisley. **L. L. S.** Corrie, (as above) Lingula Ironstone, and first Kingshaw Limestone, Carluke; Campsie; E. Kilbride.

Parallelodon (Arca) reticulatus, *M'Coy.*—**U. L. S.** Gare; Orchard. **L. L. S.** Craigenglen.

P. semicostatus, *M'Coy.*—**U. L. S.** Linn Spout, Dalry; Orchard. **L. L. S.** Craigenglen.

P. Geinitzi, *de Kon.*—**U. L. S.** Linn Spout, Dalry. **L. L. S.** Craigenglen.

Nucula gibbosa, *Flem.*—(Common.) **U. L. S.** Gare; Robroyston; George Square, Glasgow; Orchard; Waukmill Glen; Thornliebank; Swindridge and Linn Spout, Dalry. **M. I. S.** Bishopbriggs and Cadder; Robroyston. **L. L. S.** Hosie Limestone, Campsie and Thornton; Carluke; E. Kilbride; Craigenglen; Dalry; Kilwinning.

N. luciniformis, *Phill.*—**U. L. S.** Gare; Robroyston: Orchard; Waukmill Glen. **M. I. S.** Cadder; Bishopbriggs; Robroyston. **L. L. S.** Lingula Ironstone, Carluke: Campsie and Thornton, over Hosie Limestone.

N. oblonga, *M'Coy.*—(Very Rare.) **U. L. S.** Orchard; Waukmill Glen; Thornliebank.

N. aequalis, *Sow.* (*N. lineata.*)—**U. L. S.** Gare; Robroyston; George Square; Orchard. **L. L. S.** Shale above Hosie Limestone, Campsie; Thornton and Rae's Gill, Carluke; Craigenglen.

N. Scotica, *Hind.*—**L. L. S.** Craigenglen.

Nuculana (Leda) attenuata, *Flem.*—(Common) nearly always associated with *Nucula gibbosa.* **U. L. S.** Gare;. Robroyston; George Square, Glasgow; Orchard; Waulkmill Glen: Thornliebank; Swindridge, and Linn Spout, Dalry. **L. L. S.** Shale above Hosie Limestone, Campsie and Thornton; Carluke; E. Kilbride; Craigenglen.

N. Sharmani, *R. Ether. jun.*—(Rare). **U. L. S.** Garngad Road, in Shale over Cement.

N. stilla, *M'Coy.*—(Very Rare.) **U. L. S.** George Square, Glasgow; (in shale over Robroyston Limestone).

N. brevirostris, *Phill.* (*Leda longirostris*, *Leda Youngi*).—(Rare.) **U. L. S.** Gare; Orchard; Garngad Road. **L. L. S.** Carluke; Campsie and Thornton, in shale above Hosie Limestone.

N. laevistriata, *Meek and Worth.*—**U. L. S.** Orchard: Muirfoot Burn, New Cumnock; Den, Dalry. **L. L. S.** Craigenglen; Brockley, Lesmahagow

Ctenodonta (Leda) undulata, *Phill.*—**L. L. S.** Craigenglen.

C. levirostrum, *Portlock* (*Leda clavata*).—**U. L. S.** Linn Spout, Dalry: Orchard; Waukmill Glen. **L. L. S.** Lickprivick, East Kilbride.

Schizodus axiniformis, *Phill.*—**U. L. S.** Railway cutting, Garngad Road, Glasgow (in sandstone).

Protoschizodus axiniformis, *Portl.*—**U. L. S.** Gare : Garngad Road. **L.L.S.** Lingula Ironstone, Calmy and Main Limestone, Carluke ; Craigenglen : E. Kilbride : Beith.

P. impressus, *de Kon.*—**U. L. S.** Orchard. **L.L.S.** E. Kilbride.

P. obliquus, *M‘Coy.*—**L. L. S.** Shale below Main Limestone, Beith.

P. triangularis, *Hind.*—**L. L. S.** Shale below Main Limestone, Beith.

P. aequilateralis, *M‘Coy.*—**L. L. S.** Calderwood Cement-stone, E. Kilbride : Burn Anne, Galston.

Cardiomorpha oblonga, *Sow.*—**L. L. S.** Gameshill, Stewarton.

C. orbicularis, *M‘Coy,*—**L. L. S.** Newfield, High Blantyre ; Gameshill, Stewarton.

C. limosa, *Flem.* (*C. oblonga* of 1876 Catalogue). **U. L. S.** Gare ; George Square and Garngad Road, Glasgow ; Thornliebank ; Orchard. **M. I. S.** Bishopbriggs ; Cadder ; Robroyston. **L. L. S.** Beith ; Craigenglen.

C. parva, *Hind.*—**U. L. S.** Orchard; Clonbeith, Kilwinning. **L. L. S.** Waterland, Dunlop ; Gateside, Beith.

Sedgwickia scotica, *Hind.*—**L. L. S.** M‘Donald Limestone, Muirkirk ; Shale under Main Limestone, Beith ; Craigenglen.

Edmondia unioniformis, *Phill.*—**U. L. S.** Shale over Arden Limestone, Barrhead. **L. L. S.** Shale under Main Limestone, Beith ; Hindog Glen, Dalry.

E. Josepha. **U. L. S.** Garngad Road ; Browntod, near Quarter Road Station. **L. L. S.** Trearne, Dockra, and under Main Limestone, Langside, Beith.

E. Lowickensis, *Hind.*—**U. L. S.** Thornliebank ; Girtle Quarry, Dalry ; Index Limestone, Hillerhirst.

E. oblonga, *Portlock.*—**L. L. S.** Shale below Main Limestone, Beith.

E. Lyelli, *Hind.*—**L. L. S.** Newfield, High Blantyre ; Craigenglen ; Swinlees and Auchenskeith, Dalry ; Broadstone, Beith ; M‘Donald Limestone, Muirkirk.

E. rudis, *M‘Coy.*—**L. L. S.** Newfield, High Blantyre ; Craigenglen ; Shale below Main Limestone, Beith ; Hindog Glen, Dalry.

E. primaeva, *Portlock.*—**L. L. S.** Corrieburn (in Pecten Shale), Langside, Beith.

E. transversa, *Hind.*—**U. L. S.** Garngad Road. **L. L. S.** Beith ; Auchenskeith, Dalry.

E. sulcata, *Phill.*—**L. L. S.** Bathgate ; Howood ; Beith ; Carluke.

E. M‘Coyi, *Hind.*—**L. L. S.** Trearne and Dockra, Beith ; Auchenskeith, Dalry.

Scaldia fragilis, *de Kon.*—**L. L. S.** Calderwood Cement-stone, Kirktonholm, E. Kilbride.

Cypricardella concentrica, *Hind.*—(Rare.) (= *Venus elliptica* of 1876 Catalogue.) **U. L. S.** Linn Spout, Dalry ; Gare, Carluke ; **L. L. S.** Law, Dalry ; Craigenglen.

C. crebricostata, *Armstrong.*—(Very Rare.) **U. L. S.** Gare and Westerhouse, Carluke ; Arden.

C. Selysiana, *de Kon.*—**U. L. S.** Gare ; Robroyston. **L. L. S.** Craigenglen ; Law, Dalry.

C. rectangularis, *M‘Coy.*—(*Cypricardia rhombea*, of 1876 Catalogue.). **U. L. S.** Orchard ; Williamwood. **L. L. S.** Craigenglen ; Gallowhill, Strathavon.

C. acuticarinata, *Armstrong.*—(Rare.) **U. L. S.** Gare ; Robroyston ; Orchard ; Williamwood ; Linn Spout. **L. L. S.** Law, Dalry.

Sanguinolites angustatus, *Phill.*—**L. L. S.** Kersland Glen, Beith ; Craigenglen.

Sanguinolites Omalianus, *de Kon.*—L. L. S. Newfield, High Blantyre.
S. (Leptodomus) costellatus, *M'Coy.*—L. L. S. Boghead; E. Kilbride; Craigie, near Kilmarnock. Railway cutting, Gurdy near Beith, Horizon of Hurlet Limestone.
S. plicatus, *Portl.*—(*S. iridinoides.*) U. L. S. Orchard; Garpel Water, Muirkirk; 10 fathoms below Linn Spout limestone. L. L. S. Kirktonholm, E. Kilbride.
S. striatogranulatus, *Hind.*—(*S. tricostatus.*) U. L. S. Linn Spout. L. L. S. Boghead; Craigenglen; Beith Quarries; Hindog Glen, Dalry.
S. striato-lamellosus, *de Kon.*—U. L. S. Linn Spout; Craigie, Kilmarnock. L. L. S. Hindog Glen, Dalry.
S. Abdenensis, *R. Ether., jun.*—L. L. S. Corrieburn; near Cairn Bog, Kilsyth.
Allorisma sulcata, *Flem.*—U. L. S. Garngad Road. L. L. S. Shale under Main Limestone, Beith.
A. variabilis, *M'Coy.*—L. L. S. Calderwood Limestone, Kirktonholm, E. Kilbride. Dockra, Beith.
A. Ansticei. *Sow.*—L. L. S. Auchenmade, Ayrshire.
Tellinomorpha cuneiformis, *de Kon.*—U. L. S. Garngad Road. L. L. S. Thornton; Hindog Glen, and Auchenskeith, Dalry.
Solenomya primaeva, U. L. S. Thornliebank. L. L. S. Hairmyres, E. Kilbride; Bathgate.
Conocardium rostratum, *Martin.*—(Very Rare.) L. L. S. Langside, Beith; Auchenmade, and Law Quarry, Dalry.
C. aliforme, *Sow.*—(Very Rare.) L. L. S. Corrieburn, Kilsyth.
C. decussatum, *R. Ether., jun.*—(Very Rare.) U. L. S. George Square, Glasgow. L. L. S. Law, and Glencart. Dalry. Cement-shale, E. Kilbride.
C. alatum, *de Kon.*—(Very Rare.) L. L. S. Law, Dalry; Lesmahagow.

CARBONIFEROUS CEPHALOPODA.

BY JAMES NEILSON.

THE Carboniferous Cephalopods are represented by a considerable number of genera and species, which range from the Lower to the Upper Limestones, the greater number both of species and of individuals being found in the latter. A small species of *Goniatites* has been found abundantly in a thin marine band in the Upper Carboniferous series at Alexandra Parade, Glasgow, Remains of large examples of *Nautilus*, *Actinoceras*, *Orthoceras*, and *Poterioceras* occur in the limestone chiefly in the form of casts, but the good specimens which are got in the shales generally have the outer shell well preserved, some of the *Orthoceratites* still showing the remains of chevron-shaped colour-bands.

Actinoceras giganteum, *Sow.*—**U. L. S.** Orchard; Gare; Castlecary. **L. L. S.** Calderwood Cement-shale; Thornton.

A. sp. (with siphuncle larger and more compressed vertically than the above species).—**U. L. S.** Thornliebank.

Cyrtoceras Gesneri, *Mart.*—(Very Rare). **U. L. S.** Gare; Robroyston; Arden Limestone, Barrhead. **L. L. S.** Craigenglen.

C. rugosum, *Flem.*—(Rare). **U. L. S.** Orchard; Thornliebank. **L. L. S.** Calderwood Cement-shale, East Kilbride; Hairmyres; Craigenglen.

C. unguis, *Phill.*—(Common). **U. L.S.** Gare; Thornliebank; Orchard. **L. L. S.** Calderwood Cement-shale, E. Kilbride: Thornton; Craigenglen.

Orthoceras attenuatum, *Flem.*—(Common). **U. L. S.** Gare; Thornliebank; Orchard. **L. L. S.** Craigenglen; Calderwood Cement-shale: Thornton; Carluke.

O. cylindraceum, *Flem.* **U. L. S.** Gare: Robroyston: Thornliebank. **L. L. S.** Carluke; Thornton; Craigenglen (with colour-bands).

O. dentaloideum, *Phill.*—(Very Rare). **L. L. S.** Shale over Hosie Limestone, Campsie; Calderwood Cement-shale, E. Kilbride.

O.dilatatum, *de Kon.*—**U. L. S.** Gare. **L. L. S.** Corrieburn.

O. Goldfussianum, *de Kon.*—**U. L. S.** Gare. **L. L. S.** Raes Gill, Carluke; South Hill, Campsie; Thornton.

O. laterale, *Phill.*—**U. L. S.** Orchard. **L. L. S.** Craigenglen; Braidwood.

O. laeve, *Flem.*—**L. L. S.** Calderwood Cement-shales; Boghead: Newfield; E. Kilbride.

O. lineale, *de Kon.*—**L. L. S.** Netherfield, Strathavon; Balgrochan Glen, Campsie.

O. ovale, *Phill.*— **U. L. S.** Orchard; Gare.

O. Munsterianum, *de Kon.*—**L. L. S.** Shale above Hosie Limestone, Campsie.

O. pygmaeum, *de Kon.*—**U. L. S.** Shale above Hosie Limestone, Campsie, and Thornton.

Orthoceras subcentrale? *de Kon.*—**U. L. S.** Orchard; Gare; Barrhead; Bishopbriggs. **L. L. S.** Calderwood Cement-shales, Kilbride.

O. sulcatum (undatum), *Flem.*—Common. **U. L. S.** Gare; Robroyston; Orchard; Thornliebank; George Square. **L. L. S.** Hosie Limestone-shale, Thornton and Campsie. Craigenglen; Kirktonholm.

Poterioceras cordiforme, *Sow.*—(Very Rare). **L. L. S.** Craigie; Waterland; Calderside; Loudon Hill.

P. fusiforme, *Sow.*—(Very Rare). **L. L. S.** Calderwood Cement-limestone.

P. ventricosum, *M'Coy.*—(Very Rare). **L. L. S.** Calderwood Cement-shale, E. Kilbride; Calderwood Limestone, Newfield; Carluke.

Discites Leveilleanus, *de Kon.*—**L. L. S.** Calderwood Limestone series, High Blantyre, and E. Kilbride; Main Limestone, Carluke.

Stoboceras (Nautilus) sulcatus, *Flem.* (*S. quadratus*, *Flem.*).—**U. L. S.** Orchard; Thornliebank; Barrhead; Garngad Road. **L. L. S.** East Kilbride; Thornton (shale over Hosie Limestone).

Acanthonautilus bispinosus, *Foord.*—**U. L. S.** Cock of Arran (Geol. Survey).

Nautilus biangulatus, *Sow.*—**U. L. S.** Gare; Arden; Thornliebank. **L. L. S.** East Kilbride; Corrieburn; Shale over Hosie Limestone, Thornton, and South Hill, Campsie.

N. bifrons, *de Kon.*—**L. L. S.** Lugton; (type in the Thomson collection, Kilmarnock).

N. cariniferus, *Sow.*—**L. L. S.** Braidwood; Bankend, Lesmahagow.

N. dorsalis, *Phill.* (Very Rare).—**U. L. S.** Castlecary.

N. excavatus, *de Kon.*—**U. L. S.** Castlecary.

N. globatus, *Sow.*—**U. L. S.** Gare; Orchard; Cock of Arran.

N. ingens, *Mart.*—**U. L. S.** Arden; Castlecary; Muirkirk. **L. L. S.** Thornton; Braidwood; Campsie—in Main Limestone.

Pleuro-nautilus dorso-cariniferus, *Romer*, (*Nautilus nodiferus*, *Armstrong*).—**U. L. S.** Arden; Barrhead; Garngad Road; Gare. **L. L. S.** E. Kilbride in Cement Limestone shale.

Solenocheilus pentagonus, *Sow.*—**U. L. S.** Castlecary.

Temnocheilus coronatus, *M'Coy.* (*Nautilus tuberosus.*)—**U. L. S.** Arden Limestone, Barrhead; Orchard; Castlecary; Auchenbeg. **L. L. S.** E. Kilbride.

Dimorphoceras (Goniatites) Gilbertsoni, *Phill.*—**L. L. S.** Shale over Hosie Limestone at Thornton, Braidwood, and South Hill, Campsie.

D. Looncyi, *Phill.*—**L. L. S.** Boghead; Raes Gill, Carluke; Thornton, in Shale over Hosie Limestone.

Glyphioceras (Goniatites) diadema.—*Goldf.* **U. L. S.** Orchard; Thornliebank. **M. I. S.** Blackband Ironstone-shale, Dalry. **L. L. S.** Craigenglen.

G. excavatum, *Phill.*—**U. L. S.** Orchard; Gare; Thornliebank. **L. L. S.** Thornton?

G. implicatus, *Phill.*—**U. L. S.** Gare; Robroyston.

G. micronotum, *Phill.*—**U. L. S.** Orchard; Garngad Road. **L. L. S.** Shale over Hosie limestone at Campsie and Thornton.

G. mutabilis, *Phill.*—**U. L. S.** Gare; Robroyston.

G. paucilobus, *Phill.*—**U. L. S.** Gare; Robroyston.

G. Phillipsi, *Foord and Crick.*—**U. L. S.** Thornliebank.

G. reticulatum, *Phill.* (this species includes *G. Gibsoni*).—**U. L. S.** Gare.

G. sphericum, *Mart.*—**U. L. S.** Gare. **L. L. S.** Corrieburn.

G. stenobolum, *Phill.*—**M. I. S.** Robroyston; Bishopbriggs; Cadder.

G. striatus, *Sow.*—**U. L. S.** Gare. **L. L. S.** Shale above Hosie Limestone, Campsie; Main Limestone, Carluke.

G. striolatum, *Phill.*—**U. L. S.** Gare; Robroyston; Orchard; Auchenbeg. **M. I. S.** Robroyston.

G. vesica, *Phill.*—**U. L. S.** Bowertrapping; Gare; Robroyston; Auchenbeg. **L. L. S.** E. Kilbride; Thornton.

GENERAL NOTES.

By James Neilson.

In concluding my lists of the larger groups of the Carboniferous mollusca some interesting points regarding their distribution may be mentioned.

On certain horizons of both the Lower and Upper Limestone Series an associated group of shells always appears in some of the shales and the clay ironstones, and sometimes in the calmy or cement limestones. The following are its most characteristic genera:—*Nucula*, *Nuculana*, *Ctenodonta*, *Parallelodon*, and *Cypricardia*, amongst the bivalves; *Pleurotomaria*, *Murchisonia*, *Euomphalus*, *Macrocheilus*, *Naticopsis*, *Loxonema*, *Dentalium*, and *Bellerophon*, amongst the univalves; and *Nautilus*, *Cyrtoceras*, *Orthoceras*, and *Goniatites*, amongst the chambered shells.

From these same strata Corals, Crinoids, Polyzoa, and most of the Brachiopods, are absent, or at least rarely present; but, on the other hand, in the strata where these latter groups do occur abundantly, the above-mentioned group of mollusca rarely appears. It may also be stated that the above genera of mollusca are generally absent from the purer limestones, or are sparely represented by different species which do not appear in the shales. A cursory examination of any collection of Western Scottish fossils will show that all the genera named are chiefly derived from the Lower and Upper Limestone shales.

This grouping of the molluscan and other marine faunas of the Scottish Carboniferous sea-bottom has in all probability depended greatly upon the depth of water, the temperature, and the nature of the sediments which were then being deposited. The reappearance at wide intervals, and at several horizons, of strata containing such varying groups of molluscan life shows clearly that certain conditions of the sea-floor were requisite for their growth and development, and also, on the other hand, that the same conditions were not favourable to the growth of Corals, Crinoids, Polyzoa, and many of the Brachiopods.

THE CARBONIFEROUS GASTEROPODA OF THE CLYDE DRAINAGE AREA.

BY J. G. GOODCHILD, F.G.S.

THE following list of the Carboniferous Gasteropoda occurring in the Basin of the Clyde has been compiled from various sources, chiefly by Mr. A. Macconochie, Assistant Curator of the Scottish Geological Survey Collections.

The nomenclature of this section of the mollusca remains in a very unsatisfactory state, except as regards the species which have been revised by Miss Donald.

Aclisina aciculata, *Donald.*	Gillfoot; Capelrig; East Kilbride; Craigenglen.
A. attenuata, *Donald.*	Gare; Glencart; Capelrig.
A. costulata, *Donald.*	Law; Glencart; High Blantyre; Craigenglen.
A. costulata, var. **dubia,** *Donald.*	Craigenglen; Cunningham-Baidland.
A. elongata, *Fleming.*	Glencart; Capelrig.
A. elongata, var. **cingulata,** *Donald.*	Law; Crawfield.
A. elongata, var. **varians,** *Donald.*	Capelrig; Craigenglen.
A. elongata, var. **parvula.**	Law; Crawfield.
A. pulchra, var. **intermedia.**	Law Quarry, Dalry.
A. pulchra, var. **tenuis,** *de Kon.*	Robroyston; Swindridge.
A. pusilla.	Law; Glencart.
A. quadrata, *Donald.*	Law.
A. quadrata, var. **striatissima,** *Donald.*	Law.
A. similis, *Donald.*	Law; Glencart.
A. terebra, *Donald.*	Crawfield Quarry, Beith.
Bellerophon apertus, *Sowerby.*	Howrat.
B. cornu-arietis, *Sow.*	Main Limestone, Carluke.
B. (Bucania) decussatus, *Fleming.*	Gare; Robroyston; Swindridge.
B. (B.) decussatus, var. **striatus,** *Flem.*	Gare; Robroyston.
B. (Tropidocyclus) Duchastelli, *Léveillé.*	Boghead; Hamilton.
B. (Waagenella) Dumonti, *d'Orbigny.*	Bowertrapping; Craigenglen.
B. hiulcus, *Sow.*	Pandearon Burn, Kilbirnie.
B. Larcomi, *Portlock.*	Hairmyres.
B. (Waagenella) Leveilleanus, *de Kon.*	Orchard; Gare.
B. (Tropidocyclus) Oldhami, *Portl.*	South Hill, Campsie.
B. tangentialis, *Phill.*	Gare.
B. tenuifascia, *Sow.*	Gare; Woodhead, Galston.

Bellerophon (Euphemus) Urei, *Flem.*	Gare ; Orchard ; Craigenglen.
Chiton Armstrongianus, *Eth. jun.*	Williamwood ; Orchard.
C. burrovianus, *Kirkby.*	Williamwood.
C. cordatus, *Kirkby.*	Law Quarry, Dalry.
C. dalryensis, *Eth. jun.*	Law Quarry, Dalry.
C. Geikiei, *Eth. jun.*	Law Quarry, Dalry.
C. gemmatus, *de Kon.*	Gallowhill, Strathavon.
C. humilis, *Kirkby.*	Robroyston.
C. Loftusianus, *King.*	Williamwood ; Orchard.
C. soleaformis, *Eth. jun.*	Law Quarry, Dalry.
Chitonellus Bennieanus, *Eth. jun.*	Law Quarry, Dalry.
C. Kirkbyanus, *Eth. jun.*	Law Quarry, Dalry.
C. patelliformis, *Eth. jun.*	Law Quarry, Dalry.
C. subquadratus *Kirkby.*	Law Quarry ; Craigenglen.
C. Youngianus, *Kirkby.*	Craigenglen ; Cunningham-Baidland.
Dentalium (Entalis) dalryense, *Young.*	Swindridge.
D. (E.) ingens, *de Kon.*	First Calmy Limestone, Carluke.
D. (E.) inornatum, *M'Coy.*	Swindridge ; Orchard.
D. (E.) priscum, *Goldfuss.*	Gare ; Orchard ; Craigenglen.
D. (E.) scoticum, *Young.*	Dockra ; Kerrsland Glen.
Elenchus antiquus, *M'Coy.*	Robroyston.
E. subulatus, *M'Coy.*	Robroyston.
Eulima (Polyphemopsis) Phillipsiana, *de Kon.*	Orchard ; Gare ; Craigenglen.
Euomphalus, *Sow.*	
E. acutus, *Sow.*	Bowertrapping ; Craigenglen.
E. calyx, *Phill.*	Burtonhead, Stewarton.
E. (Schizotoma) carbonarius, *Sow.*	Orchard ; Thorton.
E. Dionysii, *Goldf.*	Bowertrapping ; High Blantyre.
E. marginatus, *M'Coy.*	Linn Spout.
E. (Straparollus) pentangulatus, *Sow.*	Arden ; Bowertrapping.
E. pileopsideus, *Phill.*	Williamwood.
E. pugilis, *Phill.*	Carmel Water, Kilmaurs.
E. (Raphistoma) radians, *de Kon.*	Gare ; Craigenglen.
E. serpula, *de Kon.*	Glencart.
E. tabulatus, *M'Coy.*	Linn Spout.
E. (Omphalotrochus) tuberculatus, *Flem.*	Craigenglen.
Lacuna antiqua, *M'Coy.*	Law Quarry, Dalry.
Loxonema brevis, *M'Coy.*	Gare.
L. clathratula, *Young and Armstrong.*	Robroyston ; Gare.
L. constricta, *Mart.*	Capelrig.
L. curvilinea, *Phill.*	Gare ; Robroyston ; Gurdy.
L. Lefebvrei, *Lév.*	Beith Quarries ; Main Limestone, Carluke.
L. (Orthonema) polygyra, *M'Coy.*	Cunningham-Baidland ; Gillfoot.
L. rugifera, *Phill.*	Craigenglen ; Hairmyres.
L. scalaroidea, *Phill.*	Gare ; Robroyston ; Hairmyres ; Craigenglen.
L. sulcatula, *M'Coy.*	Bowertrapping.
L. Urei, *Flem.*	Capelrig ; Boghead ; Hairmyres.
Macrocheilus (Macrochilina) acutus, *Sow.*	Gare ; Hairmyres ; Craigenglen.
M. (Polyphemopsis) fusiformis, *Sow.*	Gare ; Robroyston ; Swindridge.
M. (Macrochilina) imbricatus, *Sow.*	Orchard ; Gare ; Craigenglen.

Macrocheilus Michotianus, *de Kon.*	Robroyston ; Gare ; Boghead, Hamilton.
M. rectilineus, *Phill.*	Gare.
M. (Macrochilina) semistriatus, *Young and Armst.*	Orchard ; Robroyston.
M. tricinctus, *M'Coy.*	Gare.
Murchisonia angulata, *Phill.*	Craigenglen.
M. cincta, *Donald.*	Law ; Glencart.
M. (Stegocoelia) compacta, *Donald.*	Glencart.
M. (Hypergonia) conula, var. **convexa**, *Donald.*	Craigenglen.
M. dalryensis, *Donald.*	Dalry.
M. (Hypergonia) deplanata, *Donald.*	Law ; Glencart.
M. elongata, *Portl.*	Gillfoot.
M. (Glyphodeta) fimbricarinata, *Young and Armst.*	Robroyston.
M. M'Coyi.	Law.
M. (Hypergonia) pentonensis, *Donald.*	Law ; Craigenglen.
M. (H.) plana, *Donald.*	Law ; Craigenglen.
M. (H.) quadricarinata, *M'Coy.*	Craigenglen.
M. quinquecarinata, *de Kon.*	Robroyston ; Craigenglen.
M. quinquecarinata, var. **pulchella**, *Donald.*	Law.
M. (Stegocoelia) Smithiana, *Donald.*	Law.
M. (Aclisoides) striatula, *de Kon.*	Orchard ; Robroyston ; Swindridge ; Craigenglen.
M. (A.) striatula, var. **Armstrongiana**, *Donald.*	Law ; Craigenglen.
M. subsulcata, *de Kon.*	Craigenglen.
M. (Goniostropha) subtilistriata.	Glencart.
M. Thomsoni, *Donald.*	Craigenglen.
M. (Goniostropha) turriculata, var. **scotica**, *Donald.*	Dalry Upper Limestone series.
M. (Stegocoelia) variabilis, *Donald.*	Law, Dalry ; Crawfield, Beith.
M. Youngiana, *Donald.*	Law ; Glencart.
Naticopsis canaliculata, *M'Coy.*	Main Limestone, Campsie ; Boghead, Hamilton.
N. elliptica, *Phill.*	Craigenglen ; below Main Limestone, Carluke.
N. elongata, *Phill.*	High Blantyre ; Craigenglen.
N. lirata, *Phill.*	Arden ; Bowertrapping.
N. (Tychonia) Omaliana, *de Kon.*	Swindridge ; Lingula Ironstone, Carluke.
N. plicistra, *Phill.*	Gare ; Hairmyres ; Gillfoot.
N. robroystonensis, *Young and Armst.*	Robroyston ; Gare ; Orchard.
N. tabulatus, *Phill.*	Glencart, Dalry.
N. variata, *Phill.*	Bowertrapping ; Hairmyres ; Craigenglen.
Niso Smithiana, *Young.*	Glencart.
Orthonema pygmaeum, *Donald.*	Glencart, Dalry.
Platyceras (Capsulus) angustus, *Phill.*	Gare.
P. (C.) carinatus, *M'Coy.*	Craigenglen.
P. (C.) neritoides, *Phill.*	Orchard ; High Blantyre.
P. (C.) vetustus, *Sow.*	Gare ; Bowertrapping ; Limekilnburn.
Porcellia armata, *De Verneuil.*	Orchard ; Craigenglen ; Craigie.

Porcellia (Leveilleia) puzosi, *Lév.*	Craigenglen.
Pleurotomaria acuta, *Phill.*	Glencart, Dalry.
P. altavittata, *M'Coy.*	Bowertrapping ; Main Limestone, Carluke.
P. benediana, *de Kon.*	Robroyston ; Gare.
P. carinata, *Sow.*	Robroyston.
P. (Mourlonia) conica, *Phill.*	Gare ; Gillfoot ; South Hill, Campsie.
P. (Agnesia) contraria, *de Kon.*	Capelrig ; Boghead, Hamilton ; Hairmyres.
P. (Mourlonia) expansa, *Phill.*	Gare ; Craigenglen ; Beith Quarries.
P. frenoyana, *de Kon.*	Gare ; Orchard.
P. (Ptychomphalus) galleottiana, *de Kon.*	Craigenglen ; Hairmyres.
P. granulata, *de Kon.*	Inkerman Pits, Paisley.
P. interstrialis, *Phill.*	Glencart.
P. (Ptychomphalus) monilifera, *Phill.*	Gare ; Orchard ; Craigenglen.
P. multicarinata, *M'Coy.*	Main Limestone, Braidwood.
P. ovoidea, *Phill.*	Main Limestone, Carluke.
P. striata, *Sow.*	Robroyston ; Gare ; Germiston.
P. undulata, *Phill.*	Gare.
P. Youngiana, *Armst.*	Craigenglen.
P. (Baylea) Yvani, *Lév.*	Orchard ; Boghead, Hamilton ; Craigenglen.
Rabdospira Selkirki.	
Siliquaria (?) carbonaria, *Young.*	
Trochus (Microdoma) biserratus, *Phill.*	Swindridge ; Craigenglen.
T. coniformis, *de Kon.*	Arden.
T. (Turbonellina) lepidus, *de Kon.*	Craigenglen ; Main Limestone, Braidwood.
Turbo (Turbonitella) biserialis, *Phill.*	Broadstone.
T. spiratus, *M'Coy.*	Roughwood.

INCERTAE SEDIS.

Conularia quadrisulcata, *Sow.*	Gare ; Robroyston ; Boghead, Hamilton ; Thornliebank.

THE CARBONIFEROUS ECHINODERMATA OF THE CLYDE DRAINAGE AREA.

BY JOHN SMITH.

I AM much indebted to Dr. F. A. Bather of the British Museum for kindly undertaking the revision of the nomenclature of the following list of the Echinoderms of the Clyde drainage area. It may be added that I solely am responsible for the identification of the species included in it.

Archaeocidaris Munsteriana, *de Kon.*—L. L. S. Beith and Dalry; very rare.
A. scotica, *J. Young.*—Craigenglen, Campsie; very rare.
A. Urei, *Flem.*—U. L. S., L. L. S.; abundant.
Melonechinus Youngi, *Keeping*, sp.—L. L. S. Beith, Dalry, Muirkirk; abundant, but local.
Palaechinus sphericus, *M'Coy.*—L. L. S. East Burn, N.E. of Stewarton; very rare.
Allagecrinus Austini, *Eth. and Carp.*—L. L. S. Dalry and Howood; common at Howood.
Platycrinus laevis, *Mill.*—L. L. S. Kilsyth, Dalry, Beith.
P. trigintidactylus, *Austin.*—L. L. S. Dalry, Beith, Muirkirk.
Megistocrinus globosus, *Mill.*, sp.—Carluke; first calmy limestone; rare.
Parisocrinus quinquangularis, *Mill.*—U. L. S., L. L. S. Muirkirk, Dalry, Beith, Kilwinning.
Scaphiocrinus conicus, *Phill.*, sp.—L. L. S. Dalry, Beith.
Poteriocrinus crassus, *Mill.*—U. L. S., L. L. S. Dalry, Carluke, Thornliebank; frequent.
P. opissus, *de Kon. and Le Hon.*—Capelrig, Newton-Mearns; very rare.
Zeacrinus M'Coyanus, *de Kon. and Le Hon.*, sp.—L. L. S. Beith, Dalry, Howood; scarce.
Hydreionocrinus calyx, *M'Coy*, sp.—L. L. S. Dalry; rare.
H. scoticus, *de Kon.*—L. L. S. Boghead, Hamilton; High Blantyre.
Scytalecrinus tenuis, *Mill.*, sp.—U. L. S., L. L. S. Beith, Gare; scarce.
Ulocrinus globularis, *de Kon.*, sp.—L. L. S. Beith, Dalry, Campsie; frequent.
Rhodocrinus uniarticulatus, *de Kon. and Le Hon.*—Beith; rare.
Chiridota Robertsoni, *Eth. Jr.*—Orchard; rare.
C. primaeva, *Eth. Jr.*—Orchard.
C. Traquairi, *Eth. Jr.*—(An *Elpidiid*, not near *Chiridota*), U. L. S. Muirkirk. —L. L. S. Orchard.
Ancistrum Nicholsoni, *Eth. Jr.*—Orchard, Robroyston.

THE CONODONTS OF THE CARBONIFEROUS ROCKS OF THE CLYDE DRAINAGE AREA.

BY JOHN SMITH.

IT has long been a subject of dispute as to the order of animal life to which Conodonts belonged. Dr. Pander was the first to discover their remains, in 1856, and I found them in Scottish Carboniferous strata in 1876. I did not, however, publish my observations till 1899, so that I have had ample time to make a fairly exhaustive search for them in the rocks of the West of Scotland.[1] Being minute and very tender these organisms require to be searched for in the most careful manner. They are found chiefly in the powder of rotted limestone, and, but very rarely, in shale, belonging to the Upper and Lower Limestone series. These are indicated in the following list by letters in heavy type, **U.L.S.** and **L.L.S.** :

Polygnathus dubius, *Hinde.*—**L.L.S.**, Birkhead, Dalry; **U.L.S.**, Stacklawhill, Stewarton; Robroyston, Glasgow.

P. **(Gnathodus) mosquensis,** *Pander.*—**L.L.S.**, Cunningham-Baidland; Law and Birkhead, Dalry; Glenbuck, Muirkirk; **U.L.S.**, Glencart, Dalry; Linn Spout, Dalry; Monkcastle, Kilwinning; Stacklawhill, Stewarton; Robroyston, Glasgow.

P. **navicula,** *Hinde.*—**L.L.S.**, Poneil, Douglas.

P. **(Centrodus) connexus,** *Pander.*—**L.L.S.**, Law and Auchenskeith, Dalry; **U.L.S.**, Glencart; Monkcastle.

P. **situlus,** *Hinde.*—**U.L.S.**, Linn Spout; Monkcastle; Glencart; Orchard; Hillhead, Chryston; Limekilns, E. Kilbride.

Centrodus duplicatus, *Pander.*—**L.L.S.**, Law; Birkhead; **U.L.S.**, Glencart; Monkcastle.

C. lineatus, *Pander.*—**U.L.S.**, Linn Spout; Glencart; Monkcastle; Orchard.

Prioniodus tulensis, *Pander.*—[Skateraw, Dunbar;] **L.L.S.**, Glenbuck; Law; **U.L.S.**, Glencart.

P. **angulatus,** *Hinde.*—**L.L.S.**, Birkhead; **U.L.S.**, Glencart; Monkcastle.

P. **spicatus,** *Hinde.*—**L.L.S.**, Birkhead.

P. **peracutus,** *Hinde.*—**L.L.S.**, Law and Low Baidland, Dalry; **U.L.S.**, Glencart; Robroyston; Monkcastle; Stacklawhill; Limekilns.

P. **complex,** *Hinde.*—**U.L.S.**, Glencart; Linn Spout.

P. **genunus,** *Hinde.*—**U.L.S.**, Glencart; Linn Spout.

P. **porcatus,** *Hinde.*—**U.L.S.**, Monkcastle.

Ctenognathus obliquus, *Pander.*—**L.L.S.**, Law; Birkhead.

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[1] *Trans. Nat. Hist. Soc. of Glasgow*, 1898-1899.

INCERTAE SEDIS.

MICRO-FOSSILS IN MIDDLETONITE IN THE CLYDE DRAINAGE AREA.

BY JOHN SMITH.

ORDER CONFERVOIDAE.—*Smith.*[1]

Sphaironema curta, *Smith.*—Annandale, Kilmarnock.
S. plana, *S.*—Annandale.
S. miskensis, *S.*—Misk, Stevenston.
S. ayrshirensis, *S.*—Misk.
S. clavata, *S.*—Annandale.
S. tenuis, *S.*—Annandale.
S. (?) spinulosa, *S.*—Misk.
S. monilifera, *S.*—Annandale.
S. filiformis, *S.*—Annandale.
Nemaplana filiforme, *S.*—Annandale.
Nemaclada alternata, *S.*—Annandale.
N. dichotoma, *S.*—Annandale.
N. pulvifera, *S.*—Annandale.
N. contorta, *S.*—Annandale.
N. Beveridgei, *S.*—Misk.

ORDERS UNCERTAIN.

Peronosporoides carbonifera, *S.*—Annandale.
Leptonema tenuis, *S.*—Annandale.
Carbonacarpa annandalensis, *S.*—Annandale.

The following may belong to Crustacea or Annelida:

Corophioides polyupsilon, *Smith.*—Crawfordland, Kilmarnock; Gowkha', Kilwinning.[2]

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[1] *Trans. Geol. Soc. of Glasgow*, vol. x., 1900, p. 318, plate vii.
[2] *Ibid.*, vol. ix., 1893, p. 289, plate x.

THE CARBONIFEROUS FISHES OF THE WEST OF SCOTLAND.

By R. H. Traquair M.D., LL.D., F.R.S., F.G.S.

The Carboniferous rocks of the West of Scotland are rich in fish-remains, although entire specimens of fishes are not of such frequent occurrence as in Midlothian or North Staffordshire. I have not myself collected in the district, but I have carefully examined the Carboniferous fish-remains in the principal collections of Western Scottish Fossils, viz.:

1. The James Thomson collection now in the new Kilmarnock Museum.
2. The Hunter-Selkirk collection, in the same institution.
3. The collection contained in the Hunterian Museum, of the University of Glasgow, which includes the fish-remains collected by the late Dr. Rankine of Carluke.
4. The collection formed by the late Mr. Robert Craig, Beith.
5. The collection of Mr. John Smith, Monkredding, Kilwinning.
6. The collection of Mr. James Neilson, Glasgow.
7. The collection of Mr. Robert Dunlop, formerly of Stanrigg, Airdrie, and now in New Zealand.
8. The collection of Mr. David Sinclair, Kilmarnock.

Besides the fish-remains in these collections (to the possessors and guardians of which I must return my best thanks for facilities of inspection), I have noted those in the Edinburgh Museum of Science and Art, which, a good many years ago acquired the collection of the late Mr. James Armstrong of Glasgow, and that of Dr. Grossart of Salsburgh, Carluke.

The result of my recent examination is to confirm the conclusion at which I arrived a good many years ago, after studying the fossil fishes of Fife and the Lothians,—that so far as fish-life is concerned there are only two great life-zones—Upper and Lower—in the Carboniferous system of Great Britain. In Scotland the Upper division includes the true Coal-measures with the underlying Millstone Grit, while in the lower one may be reckoned, in downward succession, the Upper Limestone series; the Edge Coal series of Edinburgh geologists, or the "Lower Coal" series of those who dwell in the west; the Lower Limestone series; and the Calciferous Sandstone series.

The difference between the fish-fauna of these two great divisions is not, however, quite so instructively brought out in the West of Scotland as in the East, the reason being that the fish-remains from the Lower Carboniferous rocks of the West are principally from the marine limestones, while those of the Upper division or true "Coal-measures" are wholly estuarine, and in setting up "life-zones" we must, of course, compare the organisms which lived under similar conditions. This we are enabled to do better in the East of Scotland owing to the great richness in fossil fishes of the Lower Carboniferous estuarine beds there, though the list from the entire formation is not so great as that from the West, owing to the smaller extent of the Coal-measures, and the consequently smaller number of the workings. The fish-remains which have, however, occurred in the Coal-measures (Upper Carboniferous) of Fife and the Lothians belong to the same fauna as those of the West of Scotland, and of the North and West of England.

In the following list of species I have, therefore, only indicated two great horizons, the Lower and Upper Carboniferous, which are distinguished by the letters **L.C.** and **U.C.** respectively, in heavy type.

Elasmobranchii.

Diplodus gibbosus, *Agassiz.*	**U.C.**	Carluke; Newarthill.
Pleuracanthus laevissimus, *Agass.*	**U.C.**	Carluke; Newarthill; Annick Lodge; Motherwell; Airdrie.
P. cylindricus (*Agass*).	**U.C.**	Annick Lodge; Motherwell; Airdrie.
P. robustus, *Davis.*	**U.C.**	Kilmarnock Water; Newarthill.
P. alatus, *Davis.*	**U.C.**	Lugton Water.
P. denticulatus, *Davis.*	**U.C.**	Kilmarnock Water.
P. Thomsoni, *Davis.*	**U.C.**	Quarter.
P. tenuis, *Davis.*	**U.C.**	Shotts.
Cladodus mirabilis, *Agass.*	**L.C.**	Waterland; Beith.
C. striatus, *Agass.*	**L.C.**	Bowertrapping; Beith.
C. Neilsoni, *Traq.*	**L.C.**	East Kilbride.
Dicrenodus dentatus (*M'Coy*).	**L.C.**	Overton, Beith.
Janassa clavata (*M'Coy*).	**L.C.**	Overton and Broadstone, Beith.
J. linguaeformis, *Atthey.*	**U.C.**	Newarthill, Dykehead, Kilwinning.
J. Wisei, *Traq.*	**L.C.**	East Kilbride.
Petalorhynchus psittacenus (*M'Coy*).	**L.C.**	Beith; Auchenskeith.
Petalodus acuminatus (*Agass*).	**L.C.**	E. Kilbride; Trearne, Beith; Boghead; Lesmahagow; Stewarton.
Ctenoptychius apicalis, *Agass.*	**U.C.**	Carluke.
C. serratus (*Owen*).	**L.C.**	Broadstone, Beith; Auchenskeith.
C. lobatus (*R. Eth. jun.*).	**L.C.**	Brockley; Cunningham-Baidland; Gameshill; Gateside, Beith; Corrieburn, Campsie.
C. tripartitus, *Davis.*	**L.C.**	Beith.
Callopristodus pectinatus (*Agass*).	**U.C.**	Carnbroe.
Polyrhizodus magnus, *Agass.*	**L.C.**	Auckenskeith; Trearne, Beith.
Pristodus Benniei, *R. Eth. jun.*	**L.C.**	Orchard; Dockra; Auchenskeith.
Copodus cornutus, *Davis.*	**L.C.**	Beith; Lugton.
C. prototypus (*Davis*).	**L.C.**	Broadstone, Beith.
C. spatulatus, *Davis.*	**L.C.**	Beith; Lugton.
Psammodus rugosus, *Agass.*	**L.C.**	Beith; E. Kilbride; Waterland; Lugton.
Helodus simplex, *Agass.*	**U.C.**	Thornton; Fergushill; Carluke.
H. serratus (*Davis*).	**L.C.**	Waterland; Lugton; Beith.
Pleuroplax Rankinei (*Agass*).	**U.C.**	Carluke; Carnbroe; Quarter; Kilmarnock; Wellwood; Muirkirk.
P. Attheyi, *Barkas.*	**U.C.**	Carluke; Thornton.
P. falcatus, *Traq.*	**L.C.**	Overton, Beith.
Psephodus magnus (*M'Coy*).	**L.C.**	E. Kilbride; Broadstone, Beith; Auchenskeith; Brockley, Lesmahagow.

Sandalodus Morrisi (*Davis*).	L.C.	Trearne, Beith.
Xystrodus striatus (*M'Coy*).	L.C.	Craigbank ; Lesmahagow.
Poecilodus Jonesi (*M'Coy*).	L.C.	Bowertrapping; Linnspout, Dalry; Broadstone, Beith.
P. obliquus (*M'Coy*).	L.C.	Howrat. This is considered by Dr. Smith Woodward to be the lower dental plate of *P. Jonesi*.
Cochliodus contortus, *Agass*.	L.C.	Broadstone, Beith.
Streblodus oblongus, (*Portlock*).	L.C.	Broadstone and Dockra, Beith.
S. Colei, *Davis*.	L.C.	Overton, Beith.
Deltoptychius acutus, *M'Coy*.	L.C.	Roughwood, Beith ; Auchenskeith.
Orodus sp.	L.C.	Beith.
Sphenacanthus serrulatus, *Agass*.	L.C.	Barkip, Dalry.
S. hybodoides (*Egerton*).	U.C.	Shettleston ; Quarter ; Larkhall ; Newarthill ; Annick Lodge ; Fergushill, &c.
Tristychius arcuatus, *Agass*.	L.C.	Lugton ; Blackstone ; Greenside ; Barkip, Dalry ; Possil.
Euphyacanthus semistriatus, *Traq*.	L.C.	Dairy ; Waterland ; Lugton.
Ctenacanthus major, *Agass*.	L.C.	Gameshill ; Stewarton ; Beith.
C. denticulatus, *M'Coy*.	L.C.	Barkip, Dalry.
Acondylacanthus Jenkinsoni (*M'Coy*).	L.C.	Broadstone and Overton, Beith ; Loudon Hill.
Asteroptychius ornatus, *M'Coy*.	L.C.	Trearne, Beith.
Harpacanthus major, *Traq*.	L.C.	Beith.
Perissacanthus Craigi, *Traq*.	L.C.	Overton, Beith.
Cosmacanthus carnatus, *Davis*.	L.C.	Overton, Beith.
Physonemus arcuatus, *M'Coy*.	L.C.	Broadstone, Beith.
Erisonacanthus Jonesii, *M'Coy*.	L.C.	Dockra, Beith.
Oracanthus Milleri, *Agass*.	L.C.	Ringwood, Beith.
O. armigerus, *Traq*.	L.C.	Muirkirk ; Beith.
Euctonius unilateralis (*Barkas*).	U.C.	Newarthill ; Quarter ; Fergushill.
Lepracanthus Colei, *Owen*.	U.C.	Carluke.
Gyracanthus formosus, *Agass*.	U.C.	Shettleston ; Larkhall ; Quarter ; Cambuslang ; Newarthill ; Kirkwood ; Annick Lodge ; Motherwell ; Wishaw.
G. Youngi, *Traq*.	L.C.	Barkip, Dalry.
Aganacanthus striatulus, *Traq*.	L.C.	Beith.
Bertacanthus striatus, *Traq*.	U.C.	Motherwell.
B. tuberculatus, *Traq*.	U.C.	Crosshouse ; Kilmarnock.
Acanthodes Wardi, *Egerton*.	U.C.	Airdrie ; Carluke ; Kilmarnock ; Lugton Water.
Acanthodopsis Wardi (*Hancock and Atthey*).	U.C.	Carluke.

Teleostomi.

Crossopterygii.

Megalichthys Hibberti, *Agass*.	U.C.	Newarthill ; Airdrie ; Carnbroe ; Carluke ; Quarter ; Busbie Head Pit; Kilmarnock Water; Annick Lodge ; Fergushill.
M. coccolepis, *Young*.	U.C.	Quarter.

Megalichthys intermedius, *A. S. Woodward.*	U.C.	Carluke; Airdrie; Carnbroe.
M. pygmaeus, *Traq.*	U.C.	Castlehill, Carluke; Bartonholm.
M. sp.	L.C.	Howrat.
Rhizodopsis sauroides (*Williamson*).	U.C.	Newarthill; Castlehill, Carluke; Kilmarnock Water; Lugton Water; Bartonholm.
Rhizodus Hibberti (*Agass.*).	L.C.	Possil; Dalry; E. Kilbride.
R. ornatus, *Traq.*	L.C.	Thorntonhall; E. Kilbride.
Strepsodus sauroides (*Binney*).	U.C.	Carnbroe; Newarthill; Motherwell; Fergushill; Bogend.
S. sulcidens (*Atthey*).	U.C.	Annick Lodge; Fergushill.
S. striatulus, *Traq.*	L.C.	E. Kilbride; Overton, Beith.
Coelacanthus elegans, *Newb.*	U.C.	Newarthill; Castlehill, Carluke; Motherwell; Kilmarnock Water; Fauldhouse; Lugton Water; Fergushill; Bartonholm; Stevenston.
Coelacanthus abdenensis, *Traq.*	L.C.	Overton, Beith.

Dipnoi.

Ctenodus cristatus, *Agass.*	U.C.	Larkhall; Quarter; Carnbroe; Kilmarnock Water; Fergushill; Crosshouse.
Sagenodus inequalis, *Owen.*	U.C.	Newarthill; Busbie; Airdrie; Fergushill; Crosshouse, Kilmarnock.

Actinopterygii.

Gonatodus parvidens, *Traq.*	L.C.	Possil.
Elonichthys Robisoni (*Hibbert*).	L.C.	E. Kilbride.
E. Egertoni (*Egert.*).	L.C.	Carluke.
E. Aitkeni, *Traq.*	U.C.	Carluke; Crosshouse.
E. pectinatus, *Traq.*	L.C.	E. Kilbride.
E. multistriatus, *Traq.*	L.C.	Broadstone, Beith.
Acrolepis Hopkinsi, *M'Coy.*	L.C.	Braidwood; E. Kilbride.
A. Hopkinsi, *M'Coy.*	U.C.	Kilmarnock Water.
Rhadinichthys ornatissimus (*Agass*).	L.C.	E. Kilbride.
R. Grossarti, *Traq.*	U.C.	Shotts; Crosshouse.
R. monensis (*Egert.*).	U.C.	Stevenston.
Nematoptychius greenocki (*Agass*).	L.C.	Possil.
Eurynotus crenatus, *Agass.*	L.C.	Possil; Crawford, Beith.
Cheirodus granulosus (*Young*).	U.C.	Lugton Water; Fergushill; Cauldhame.
C. crassus, *Traq.*	L.C.	Overton and Langside, Beith; Auchenskeith.
Mesolepis sp.	U.C.	Carluke.
Platysomus parvulus, *Young.*	U.C.	Carluke; Cauldhame.
P. Forsteri (*Hancock and Atthey*).	U.C.	Newarthill.

It will be observed that of the 99 species contained in the above list 58 have been obtained exclusively from the Lower, and 39 exclusively from the Upper division of the Carboniferous formation, while one only (*Acrolepis Hopkinsi*) has occurred in both.

It is true that a large proportion of the fishes of the Lower Carboniferous rocks of this region are marine, while those of the true Coal-measures are entirely estuarine, but in the East of Scotland, where those of the Lower division are likewise mostly estuarine, almost as marked a difference obtains as regards species, though there is of course a greater similarity in general facies. Consequently as we can there compare estuarine with estuarine forms, the break in the Carboniferous fish-fauna which occurs at the top of the Upper Limestone series is, as I have already remarked, brought home to us with all the greater force.

THE AMPHIBIA OF THE CARBONIFEROUS ROCKS OF THE CLYDE DRAINAGE AREA.

By the late Dr. John Young.

Only a few genera and species of Amphibians have been found in the fresh-water or brackish-water strata from Lower Limestones to the higher beds of the Upper Coal-measures, and usually in a fragmentary state.

Labyrinthodontia.

Anthracosaurus Russelli, *Huxley.*	Blackband Ironstone, Airdrie and Quarter.
Loxomma Allmanni, *Hux.*	Shale, Drumgray Coal, Carluke; Palacecraig Blackband, Carnbroe.
Megalerpeton plicidens, *Young and Thomson.*	Blackband, Quarter.
M. simplex, *Y. and T.*	Blackband, Quarter.
Pholaderpeton, sp.	Blackband, Quarter; Blackband, Palacecraig.
Pteroplax cornuta, *Hancock and Athey.*	Blackband, Quarter; Ironstone, Raes Gill.

THE PERMIAN ROCKS OF THE CLYDE DRAINAGE AREA.

By JOHN SMITH.

As observed by Sedgwick, Binney, Harkness, and Goodchild, the Permian rocks of England are unconformable to the underlying strata, and the patches of this formation in the Clyde drainage area occupy a similar position.

BALLANTRAE DISTRICT.

Just north of Ballantrae harbour and on the shore, there is a narrow patch of Permian rocks. It consists of (*a*) a subangular conglomerate of a reddish tinge at parts bound together with calcite, the contained pebbles being evidently derived from the local Silurian rocks, greywacke, and trap, and having suffered very little tear and wear, generally no more than their angles having been removed. (*b*) From a short way N. of the harbour and on to near Bennane Head there is an exposure of fine-grained red sandstone closely resembling that of Mauchline. The beds dip gently, and are frequently cross-bedded and ripple-marked. It is so soft that the recent mollusc *Pholas crispata* bores freely into it.

These beds have been bored for coal, and fresh water issues from a bore-hole under high-tide mark. They terminate abruptly a short distance inland, and may be faulted against the Silurians. A few narrow trap dykes cut through them.

MAUCHLINE DISTRICT.

The Permian rocks of this district occupy a "pear-shaped" area, 9 miles by 6 at its widest part. The lower beds consist of a series of "porphyrites, melaphyres and tuffs, the product of volcanic vents which were active during the earlier part of the Permian period." ("Explanation" sheet 14, Geol. Survey.) They form a ring with an average width of less than a mile, and doubtless extend under the red sandstones, which at parts are seen to rest on them. There is, however, no definite line of junction, the tuff dovetailing into the sandstone lying above it.

The Permian sandstone is well exposed on the Water of Ayr at Ballochmyle and Barskimming; on the Lugar Water, near Auchinleck; and in several large quarries near Mauchline. It resembles that of the Ballantrae district, and probably is largely a subaerial formation, although some of it as exposed in the railway cutting between Mauchline station and the Mossgiel tunnel has evidently been laid down in water. The thickness of this patch is not known, but is at least several hundreds of feet. Towards its upper part, bombs of the characteristic Permian volcanic, steatitic, and tender amygdaloidal rock occur in the sandstone, showing that towards the close of its formation (so far as seen here) volcanic activity had again set in. A volcanic vent is seen at the north end of the Mossgiel tunnel. Carboniferous Coal-measure rocks extend all round this Permian area, and doubtless under it.

ARRAN.

The geological position of the red sandstone strata of Arran had long been a matter of dispute till the discovery on the N.E. shore of a conglomeratic underlying sandstone which closely resembles that of Mauchline, proved at least that they were of post-Carboniferous limestone date and were in all likelihood of Permian age. (*Trans. Geol. Soc. of Glasgow*, vol. xi., 1898, p. 29.) The sandstones closely resemble those already described, but the conglomerate is entirely different from that of Ballantrae, and that of the Snar Valley to be presently mentioned. It contains pebbles of limestone with at least 29 species of Carboniferous fossils; the other pebbles consisting of quartz, varieties of trap, and fragments of sandstone.

The patches of red sandstone near Corrie and at Maoldon may be of Permian age, and have evidently been influenced, as to their dip, by the granitic nucleus of the island.

SNAR VALLEY.*

In the Snar Valley, between Crawfordjohn and Leadhills, there is a suboval area of two miles by one mile, its long axis running N.N.W. and S.S.E. With the exception of a few feet of sandstone it is entirely composed of conglomerate with pebbles of greywacke and radiolarian chert. It dips towards Glendowran Hill (1543 feet) and Brown Hill (1603 feet), at about 20° on an average. Close to the east boundary, on these hills, the dip becomes *reversed* and increases to as much as 60°, which apparently indicates that since the Permian strata were deposited they have been let down or the hills have been elevated. They rise from 850 to 1350 feet above sea-level. The conglomerate has a considerable resemblance to that of Ballantrae, and like it is occasionally cemented by calcite, the greywacke pebbles being stained (generally to their centres) of a reddish colour, and occasionally reaching a diameter of two feet. (*Trans. Geol. Soc. Glas.* vol. xi.) It is seen at one part to rest on the upturned edges of Silurian strata, also stained to some depth by the red colouring matter of the conglomerate.

At Bothwell the Clyde cuts through red rocks, but they are probably just the upper part of the Coal-measure strata, although some of the beds closely resemble the sandstone of Ballochmyle.

No fossils having been found in the Permian patches of the Clyde area, it is entirely on lithological and stratigraphical evidence that these remnants of an evidently once more extensive formation have been relegated to the Permian period.

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* For a detailed description of this deposit see the author's paper, *Trans. Geol. Soc. of Glasgow*, vol. xi., part 2, 1900, page 250.

THE DRIFT OR GLACIAL FORMATION OF THE CLYDE DRAINAGE AREA.

BY JOHN SMITH.

THE DRIFT BELOW SEA-LEVEL.

THE Clyde Drift-deposits extend to at least 230 feet below sea-level,[1] and to 1750 feet above it.[2] In a bore at Millichin, near Garscadden, 355 feet of drift-beds were passed through, the bottom being 221 feet below the present sea-level. These contained probably six Boulder-clays of varying shades of colour.[3] In another bore at Drumry the bottom of the drift was 230 feet below sea-level.

It has been shown by Messrs. Croll and Bennie that a deep drift-filled gutter extends between the Clyde and the Forth in the hollow at present occupied by parts of the River Kelvin and the River Carron. As far as borings give the information the highest part of that hollow cannot be far, geographically, from the present watershed at Kilsyth, the bottom of the trough there being 15 to 20 fathoms below the level of the canal. The hollow E. of that deepens even more—at least 252 feet below sea-level—than that yet proved on the Clyde side. Several Boulder-clays have been passed through in the bores (as on the Clyde end of the hollow), but in the shallow portion near Kilsyth "only sand and gravel has been found." Shells of mollusca and foraminifera have been occasionally recorded from these beds, but no attempt was made to "work" them systematically for organic remains when the borings were made. At a little below and above sea-level a series of beds with Arctic shells, etc., is found, but as they are evidently of more recent date than the drift-beds higher up country I shall take the latter as first in order.

THE DRIFT ABOVE SEA-LEVEL.

The drift is only occasionally seen on the shore-level, as at Ardneil Bay, where the surface is composed of a tough reddish Boulder-clay; on the Garnock Water and the Water of Irvine; on several parts of the coast between Gourock and Skelmorlie; and in some of the sea-lochs. This paucity of drift on the sea-margin is owing to the immense time that the waves must have acted both on it and the adjoining rocks during the Raised Beach period, and also the recent one when it was cut off from that below sea-level. The last Raised Beach epoch is represented in the Clyde by a platform or terrace about 10 feet above high-tide mark, and that it was of great duration is shown by the present line of cliffs on its landward side.

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[1] J. Bennie, *Trans. Geol. Soc. of Glasgow*, vol. iii., part 1, 1868, p. 139.

[2] The author, *Ibid.*, vol. xi., supplement, 1898, p. 83.

[3] J. Bennie, *Ibid.*, vol. iii., part 1, 1868, p. 139.

At present it is the fashion to regard the close of the glacial period as of comparatively recent date—8000 years even having been suggested. North of Portincross there is a Raised Beach cliff a mile long, composed of reddish sandstone and pink trap, rising to a vertical height of 300 feet, west of which, during the Raised Beach period, a quantity of rock of probably at least 9,000,000 of tons must have been weathered from the face of the retiring cliff, ground into sand and mud, and carried off by the waves and currents. The talus of this cliff amounts to more than 100,000 tons. Where the rock is composed of sandstone and conglomerate the talus is a reddish clayey sand with pebbles and large masses of sandstone, but where the sandstone is capped by trap, 150 feet thick, the talus has also large blocks and shivers of trap. Some of the blocks from this cliff rest on Raised Beach shelly beds which they have protected from decay.

Advocates of the theory of a short period of time since the close of the glacial period must bear in mind that there are no extinct shells in the Raised Beach beds of the Clyde, nor any boulders, and that little or no alteration in sea-level has taken place since Roman times, and very little since Iverian ones.

Above sea-level, the drift rises to at least 1750 feet, as already stated, and like that below it contains several beds of Boulder-clay—sometimes four. On some parts of the coast-line there are high and old "scars" of drift, as N. of Girvan and N. of Ballantrae. An exposure 3 miles N. of the latter shows:

Boulder-clay, with a few shelly fragments, . .	98 feet.
Reddish sand, with decaying shells, ...	28 "
Dark-red clay, with a few stones and solid shells,	
Gravel and sand, with rotted shells, . . .	21 "
Boulder-clay, only occasionally seen, . . .	5 "

The base of this section, not seen, is probably about sea-level.

The drift-beds as we ascend in altitude generally become thinner, and at about 1100 feet, in Ayrshire at least, no intercalated beds have been recorded —only Boulder-clay. In a recent investigation of the deposits cut through by the new railway from Elvanfoot to Wanlockhead in Lanarkshire I observed that there is no Boulder-clay above 1000 feet, and that all the drift is well-stratified, sometimes containing large foreign blocks.

In no part of Scotland are the drift-deposits better seen, perhaps, than in Ayrshire, the strata in many of the sections lying almost horizontal, or dipping with the valleys. There is clear evidence of extensive deformation having taken place, sometimes during their deposition, but occasionally after it, and there is an almost continuous exposure of the shelly-drift from sea-level to a height of 1061 feet above it.[1] The shells are generally preserved in the Boulder-clay or in stoney clay, though sometimes in sand or gravel, or in clay layers in the sandy beds and in laminated clay.

In Lanarkshire shelly-drift occurs on the Douglas Water at 1060 feet, and for two miles down stream. Recently I have obtained marine fossils at even a higher level on the Powbrane Burn. In other parts of the Clyde area shells have been found in the drift from near to over 1100 feet above sea-level.

SHELLS IN THE BOULDER-CLAY.

It must have been noticed by most observers that shells in the Boulder-clay exist almost always as fragments or as single valves, though these are often in such a fine state of preservation that it is impossible to suppose they have been transported any distance. The fine teeth of the most delicate *Leda* are in the most perfect preservation, and the epidermis is often retained. True, some of the shells are scratched, and in such cases must have been dragged a little. But how the valves have been so generally disjoined it is not easy to explain.

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[1] *Trans. Geol. Soc. of Glasgow*, vol. xi., supplement, 1898, p. 113.

That the Boulder-clays are marine deposits does not, I think, admit of doubt; they are frequently stratified, they often contain passage-beds between them and their associated sand and gravel beds, and they shade into laminated clays interbedded with them. These, taken with the fact that they often contain an abundance of marine fossil remains, afford strong proofs that Boulder-clays have been deposited in the sea.

The coast of Ayrshire lies well open to the Atlantic, and it is difficult to see how its drift could be a deposit from land-ice carrying "ground-moraine" uphill, as some geologists maintain. It is generally admitted that before the glacial period the land stood much higher than it does at present, but this only increases the difficulty of understanding how marine remains could have been transported uphill by land-ice.[1]

But how are the drift-shells so uniformly single-valved? It may be suggested that after the large ligaments have decayed or been eaten by microzoa the valves would easily fall asunder by agitation of the water caused by the falling of stones from floating ice, and probably a large proportion of the shells were smashed by the same agency.

DRIFT PECULIARITIES.

The Original Ground-Moraine is a thin layer on top of the rock which differs from any of the drift above it, and is, I believe, the only deposit of the kind ever formed by land-ice. Where the drift has been dragged (*a*) by the stranding of icebergs, (*b*) by glaciers pushing into the sea amongst deposits, or (*c*) by subsequent land-ice dragging the beds, it has been converted into what may be called *secondary* ground-moraine.

Boulder-clay is seen sometimes resting on rock entirely different in colour from itself even at the point of contact, and it is often difficult to know, on the one hand, where the Boulder-clay ends and the gravel or laminated clay begins. On the other hand, it is puzzling to decide as to whether a bed is simply clay or Boulder-clay, as sand, gravel, and clay often contain large blocks, and gravel is sometimes very clayey, as may at present be seen at Blackhall, near Paisley, where it also contains boulders, is stratified, and lies under true Boulder-clay.

Unscratched Angular Stones, well-scratched stones, and unworn and unscratched shells, are often got lying near each other in Boulder-clay.

Boulders versus *Stones.* The latter are found often in the drift, whereas boulders are the exception, though they are conspicuous from their size.

Lines of Boulders are frequently seen in sections in the Boulder-clay, but the arrangement is only noticeable when they extend over a considerable space.

Ripple-marked Sand is occasionally seen interbedded in the drift, as in sections on the Guelt Water.

Manganese Gravel. Black gravelly beds stained by the binoxide of manganese are sometimes seen in the drift.

Drift on Steep Hill-sides seen in sections on the burns is always very stoney and sometimes stratified.

Crumpled Mud is occasionally met with in the drift under normal beds.

Vertical Burrows in Sand are found in thick Boulder-clay at Newmilns.[2]

Sand-dykes in Boulder Clay are rare, but in Crawfordland Burn eight are exposed within a few yards, at about 380 feet above sea-level, and dip with the valley at about 80°.[1]

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[1] The Norwegian expedition to Greenland of 1876, 1878 found remains of a littoral fauna down to 6000 feet below sea-level.

[2] *Trans. Geol. Soc. of Glasgow,* vol. xi., supplement, 1898, p. 31, fig. 10.

Passage-beds from Boulder-clay to Sand are well seen on Changue Burn, in Galston parish, 700 feet above sea-level.

Peat and Vegetable Matter in Drift are found:—under a sand-bed in Boulder-clay at Gamesloup, 70 feet[2]; at Burnhead, near Airdrie[3]; in sand under thick Boulder-clay on Guelt Water, at 860 feet above sea-level[4]; on Patrick Burn, Muirkirk, in Boulder-clay and resting on a rotted surface of the same material, at about 1000 feet above sea-level; on Afton Water, but doubtfully if *in situ*, at 1350 feet above sea-level.

Shore-lines and Gravel Terraces. Near the "Windy Wizzen," E. of Darvel, the officers of the Survey have shown on the 1 inch map No. 22, "an old sea-beach about 700 feet above sea-level." Lately, I saw that, where exposed, large blocks of trap from the great scar on the south face of Loudon Hill had at one time rolled down on the top of this sand and gravel deposit, so that this cliff may have been the work of the waves helped by floating-ice. Terraces of sand and gravel occur near Eaglesham 535 to 900 feet above sea-level,[5] and among the Moorfoot Hills at 1050 to 1100 feet.[6] Where Boulder-clay has been denuded away, sand and gravel are often exposed on the surface over small areas, as on the Annick Water at 620 feet above sea-level, where they may be seen going under Boulder-clay.

Hill-Benches backed by Cliffs or Banks are occasionally seen at Loudon Hill; Glen, near New Cumnock about 900 feet above sea-level; Ponesk Valley, Muirkirk, at about 1300 feet[7]; and in many places to much higher altitudes on the hills near the higher tributaries of the Clyde.

Old Drift-filled Glens are frequent, the rivers having at many places left their old glens and cut new ones, often out of solid rock.[8]

Post-Glacial Glens cut in Rock. Examples of these are:—the Mouse Water, Lanark; Craignethan; Ness Glen, Loch Doon; Boreland Glen, near Patna; Hindog Glen and Cleaves Glen, Dalry; and the gorge in the Permian rocks near Barskimming.

Old Land-Surfaces have been found in the drift 300 to 400 feet above sea-level, near Beith, with roots of oak, hazel, and other trees, between Boulder-clays.[9]

Angular Blocks.—In the moraine of the Ford of Moak, Loch Doon, there is a great assemblage of angular blocks, which to all appearance have never been rubbed, and were probably carried on the surface of a glacier.

Dry River Channels occur near Muirkirk, New Cumnock and Ballantrae, and are cut out both of rock and drift. They have probably been formed by streams diverted from their normal courses by ice-dams.[10]

BOULDERS.

According to the late Mr. Allport there is not a boulder in Arran foreign to the island, and although it is a strong statement I know of no contradictory evidence. The principal carriage of the granite blocks has been S. and towards the Atlantic, very few having, apparently, come E. Across the Firth of

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[1] *Ibid.*, p. 38, fig. 15. [2] *Ibid.*, p. 12, fig. 2.

[3] *Ibid.*, vol. viii., part 2, 1888, p. 312.

[4] *Ibid.*, vol. xi., supplement, p. 73.

[5] James Geikie, *Great Ice Age*, 3rd ed., 1894, p. 175, fig. 46.

[6] *Ibid.*, p. 177.

[7] *Trans. Geol. Soc. of Glasgow*, vol. xi., supplement (referred to in Index).

[8] See paper by the author on "The Buried or Drift-filled Glens and Channels; and the Post-glacial Glens of Ayrshire," *Annals of the Andersonian Naturalists' Society*, vol. ii., pp. 51-66.

[9] R. Craig, *Trans. Geol. Soc. of Glasgow*, vol. iv., part 2, 1873, p. 138.

[10] *Trans. Geol. Soc. of Glasgow*, vol. x., part 2, 1896, p. 331.

Clyde in Ayrshire I have seen no Arran granite above the 100 feet contour, and very little below it, indeed not more that might have been introduced by human agency. In the island itself many large granite blocks have come east. A few north Highland schistose rocks are abundant in the northern part of the Clyde area, and extend as far S. as Muirkirk (perhaps to Wanlock Water). They have been long known to the country folk as "Heelan Whin." Boulders of mackled granite, possibly from Ben Cruachan, but more probably from the patch of similar granite which lies E. of the head of Loch Fyne at Loch Garabal,[1] diorite from Glen Falloch, and actinolite (hornblende) probably from near Loch Tay, are occasionally got. Knype granite from New Cumnock is found towards the head-waters of the Clyde, more especially in the district between the Lowthers and the Crawick Water.

Spango granite is frequent about Muirkirk, Douglas Water, and the head-waters of Glenmore Water and Crawick Water. On a recent investigation I found that the Spango granite boulders extended for several miles all round the outside of the granitic area. Watstone Hill granite is frequent in the upper part of the Irvine valley, but less so about Strathavon, an occasional block having found its way as far to the N.N.W. as Kilwinning and as far E. as the Nethan Water. The granite to the south of Loch Doon and Loch Bradan is found in immense quantities in the valleys of the Doon and the Girvan, and along the Carrick shore, and has come N. as far as Portincross, and S. to Leadhills as seen in recent railway cuttings, and also some way West. Boulders are sometimes seen lying with their long axes in the same direction as the rock-striae, but they are also found lying across them, in fact in all ways, and sometimes even standing perpendicularly in the drift.

Rock-Striae.

Perhaps these should have been partly treated of first of all, but it is extremely difficult to discriminate between the first formed striae and the later ones. Those on rock-faces are often taken as indexes to the direction from which the drift was carried along and deposited by land-ice, but I believe the striae have nothing to do with the drift-beds above them. It is evident that glacier-ice was in motion long ages before they were deposited, the old rotted rocks having in many parts been previously removed; and the condition of the majority of the stones and boulders in the drift shows that they were derived from solid rock and not from the rotted surface-rock. At the present day, for instance, solid serpentine cannot be got from the outcrops, except on the sea-shore or from underdrift, but it can be obtained in first-rate condition from the Boulder-clays of Lendalfoot, etc. Where the bottom beds of drift are composed of gravel there are no striae on the rock-faces under it. In the higher reaches of the Clyde area some of the rotted greywacke and Spango granite may date from pre-glacial times.

The directions of the rock-striae in the Clyde area are briefly:—On the Ayrshire coast, S. of, or parallel to, the coast-line; in the lower part of the Doon valley, N.W., or with the valley; at Loch Doon, nearly N., or with the valley and loch; in N.E. Ayrshire, S.W., or with the valleys; in the upper hilly part of the Garnock valley, S.E., or with the valley; on the head waters of the Irvine, W., or with the valley; at Fairlie, S., or with the shore (or Clyde valley); at Little Cumbrae, the same; in Renfrewshire, from Greenock to Paisley, E.S.E.; on Loch Lomond, S.S.E., or in the direction of the loch; at Airdrie, E.; at Lanark and Carnwath, E.N.E.; in Bute, S.S.E., the direction of the Firth of Clyde valley; on the upper part of Loch Fyne, S.S.W., or with the loch; in the lower part of Kintyre, both across and with the long axis of the peninsula.

It will be seen from this that the direction of the striae generally follows the slope of the ground (though sometimes they are at right angles within short distances, or even on the same rock-surface) so that the bulk of the evidence is in favour of their having been produced by the action of land-ice, *before* the drift-beds were deposited, but some of them may have been caused by icebergs during a depression of the land. Striae occasionally ascend on rock-surfaces, as in Bute, at Ashgrove near Stevenston, in Dunnach Burn, Ballantrae,[1] in Loch Doon, and in the Afton valley.

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[1] Hopkins, *Q. J. G. S.*, 1850.

ROCK-DRUMS.

In the low grounds rock-drums often occur, probably under drift, and near the coast examples are sometimes laid bare, as at Bennane Head, N. of Ballantrae. In the valleys hemmed in by steep-sided hills—especially where the rocks are of unequal hardness[2]—they are very numerous. Perhaps the finest display of them in the Clyde area is on the hill-slopes in the lower eastern part of Noddsdale, and in the upper part of the Girvan valley. On the moors they are abundant, and permanently wet rock-faces often have them very well preserved. The long axes of rock-drums are usually with the striae.

DRIFT-DRUMS.

The 60-feet and 40-feet Raised Beaches occasionally rest on Boulder-clay drums. Up to 800 feet above sea-level there are immense numbers of drift-drums, their long axes being generally with the valleys, but sometimes across them. Above that height clusters of small drift-drums occasionally occur in the narrow valleys and usually at the junction of a side valley with a larger one.[3] It is quite evident that many at least of the drift-drums have been carved out of stratified deposits by glacier-ice.[4] A drift-drum is sometimes found resting on top of a rock-drum. The waves during the last Raised Beach period truncated the large drift-drums N. of Girvan and Ballantrae,[5] and drift has in many places, like beds of rock, been entirely carried away by glacier-ice.

MORAINES.

These remains of ice-action are singularly scanty. Some of the fishing "banks" in the Clyde estuary may be the upper surfaces of either moraines or drift-drums. At low levels near the mouths of some of the Highland glens a few occur, like the remarkable one near Row; on Loch Lomond-side N. of Balmaha; and in Arran. The fine example in Glen Fruin has a ground plan of nearly semicircular outline, with a length of about 4 miles, and climbs the hills on either side to a height of several hundred feet.[6] There are also the Colmonell moraine[7]; the Cuffhill moraine; the Penwhapple, Polreoch, and Avon moraines, about 750 feet above sea-level.[8]

KAMES.

Carnwath is the great centre for the peculiar accumulations of stratified sand and gravel which are known as kames. There they present the appearance of a "tumbled sea . . . the ground now swelling . . . into beautiful peaks and cones, and anon curving up in sharp ridges that often wheel suddenly round so as to enclose a lakelet of bright, clear water."[9] Somewhat similar surface-features are to be found near Maybole. Some kame-like hillocks of drift are probably due to recent river-denudation, as near Skelmorlie; in the angle between the Avon Water and the Glengavil Water; and near

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[1] *Trans. Geol. Soc. of Glasgow*, vol. xi., supplement, p. 68. [2] *Ibid.*, p. 104, fig. 42.
[3] *Ibid.*, pp. 45, 101, 102. [4] *Ibid.*, p. 16, fig. 4. [5] *Ibid.*, p. 118, fig. 49.
[6] Renwick, *Trans. Geol. Soc. of Glasgow*, vol. x., 1895, p. 96.
[7] *Ibid.*, vol. xi., supplement, p. 19. [8] *Ibid.*, pp. 66, 67, figs. 29, 30, 31.
[9] J. Geikie, *Great Ice Age*, 3rd ed., 1894, p. 181.

Muirkirk. From a recent investigation of the Carnwath and Carstairs kames I have come to the conclusion that they are the result of river and ordinary denudation acting on a large delta of drift.

Localities of Marine Fossiliferous Boulder-clays.

These may be defined as:—(*a*) *Beds below sea-level*, in the hollow between the Clyde and the Forth; (*b*) *Beds at or near sea-level*, at Drumuir, near Dreghorn, in sand, with remains of *Elephas primigenius*, under 76 feet of Boulder-clay; and (*c*) *Beds above sea-level.*

The following list gives the latter with their respective heights in feet:—

12.	Warwickhill, near Dreghorn, Ayrshire.
30-60.	Bennane Head, near Ballantrae.
40.	Annick Water, near Dreghorn.
90.	Cundry, near Lendalfoot.
94.	Woodhill, near Kilmaurs (the Mammoth bed).
100.	Currarie Glen, S. of Ballantrae; Croftamie, near Drymen.
130.	Tangy Glen, near Campbeltown.
140.	Water of Ayr.
180.	The River Doon, below Cassillis.
200.	The Water of Ayr at Gadgirth; Sevenacres nr. Kilwinning.
200-460.	Crawfordland Burn near Kilmarnock.
230.	The Water of Ayr.
240.	Byne Hill Burn near Girvan.
260.	The Water of Ayr, Barskimming.
260.	Score Burn, Newmilns.
290-380.	Lugar Water below and above Ochiltree.
300.	Water of Ayr, opposite Stair House.
310.	Broomhouse near Auchinleck.
320.	Near Lag in Arran.
340.	Barturk near Ochiltree.
350.	Airdrie.
360.	Near Ochiltree Sawmill, a wooded bank.
370.	Coyle Water opposite Drongan Mains.
380.	"Timmer Brig," Water of Ayr, near Sorn.
400-430.	Burnock Water near Ochiltree.
400.	Crawfordland House.
425-550.	Annick Water.
428.	Water of Ayr, below High Holehouse.
430-690.	Polbaith Burn, N. and N.E. of Galston.
447-560.	Water of Ayr at Nether Heiler.
450.	Water of Ayr near High Holehouse.
450-560.	Glen Water, above Darvel.
500.	Lugar Water near Longhouse.
510.	Chapelhall near Airdrie.
520-550.	Merkland Burn, E. of Sorn.
560-580.	Hareshawmuir Burn, N. of Galston.
570-600.	Airds Moss; and Water of Ayr.
580.	Annick Water, at Blacklaw.
600.	Westown Burn, Merkland Burn near Sorn; Annick Water at Blacklaw; Glen Water at Laigh Braidlie.
620.	Whitehaugh Water, between Muirkirk and Sorn.
650-670.	Greenock Water, near Muirkirk.
660-680.	Merkland Burn, near Sorn.
680.	Glenmore Water at Dornal.
700.	Changue Burn, at Score Tulloch, Galston; Glenmore; Merkland Burn.

720-740. Hole Burn, E. of Sorn.
750. Dunton Water, in puddle trench, N.E. of Fenwick.
780. Muirfoot Burn, New Cumnock.
800. Greenock Water ; Guelt Water.
880-900. Guelt Water, N.E. of New Cumnock.
920. Coyle Water above Rankinston.
1000 (above). Patrick Burn, near Muirkirk.
1060. Douglas Water, and 2 miles down stream.
1061. Dippel Burn, between Muirkirk and Lesmahagow, and for ¼ mile down stream.

Since the above was drawn up I have found remains of marine fauna in drift on Pockmuir Burn, about 1000 feet ; on Nethan Water, over 1000 feet ; and Powbrone Burn, over 1100 feet above sea-level.

FOSSILS IN DRIFT OR BOULDER-CLAY.

None of the localities mentioned in the preceding list have been systematically "worked" for fossils, but I have got from them the following molluscan remains. Mr. Joseph Wright, F.G.S., has recorded 42 species of Foraminifera obtained from them, these organisms having been extremely abundant in some of the Boulder-clays. As many as 3000 specimens were obtained from less than 10 lbs. weight of clay taken from high levels.

Ostracoda, 11 species.
Crisia eburnia, L.
Verruca strömia, Mull.
Balanus crenatus, Brug.
B. porcatus, Da Costa.
** *Pecten islandicus*, Mull.
** *P. groenlandicus*, Lane.
** *Leda pernula*, Mull.
L. pygmaea, Munst.
L. pygmaea, var. *Gouldi.*
Nucula tenuis, Mont.
Cyprina islandica, L.
Cardium sp.
** *Astarte borealis*, Chem.
A. sulcata, Da Costa.
A. compressa, Mont.
Tellina balthica, L.
** *T. calcarea*, Chem.
Montecuta elevata, Stimp.
Mactra, *sp.*
Venus ovata, Penn.
Saxicava rugosa, L.
Mya truncata, L.
Corbula gibba, Olivi.
Trochus, *sp.*
Littorina littorea, L., worn specimens.
Turritella terebra, L.
Natica groenlandica, Beck.
N. affinis, (*N. clausa*), Gmel.
Aporrhais pes-pelecani, L.
Buccinum (or *Fusus*).
Burrows of boring Sponges.
Burrows in sand under Boulder-clay.
Borings of Gasteropods in shells.
Many Plant-remains, not identified.

NOTE.—Those species marked ** are now extinct in British seas.

THE POST-DRIFT FOSSILS OF THE CLYDE DRAINAGE AREA AT LOW LEVELS.

By John Smith, Thomas Scott, F.L.S., and James Steel.

A short distance below and above the present sea-level in the Clyde area there occur a series of beds containing Arctic shells, many of which are now extinct in the Clyde estuary and in British seas. These beds sometimes rest on rock or Boulder-clay, but often on a very fine-grained laminated clay which contains no organic remains except a few foraminifera.

The deposits passed through in sinking coalpits at Bogside, Lucknow, and Misk, on the Ayrshire coast, may have belonged to the same period. In the latter pit they reached a depth of 42 feet below sea-level. Large scratched boulders, covered with polyzoa, etc., were found in them, along with Arctic shells.

The Raised-Beach beds are clearly distinguished from the glacial or Post-drift deposits above mentioned, (*a*) by the absence of boulders, (*b*) by the absence of extinct shells of boreal habit, and (*c*) by the presence of remains of the recent Clyde estuarine fauna. Only the youngest Raised-Beach (which lies at about 10 feet above present high-tide mark) and the 40-feet one possess distinctive features and show fairly continuous lines, but the others occur in patches, up to a height of 120 feet above sea-level. As these beaches principally consist of sandy deposits, the organic remains have now either wholly disappeared from many of them or are only represented by decayed fragments. To this there is one notable exception: this is the 40-feet Beach at Shewalton near Irvine, which still contains quantities of shells, and these are exposed after floods in the river.

The lower Raised-Beaches contain at least two beds of peat *in situ* as they were laid down, which are covered by shelly deposits, bearing evidence to changes of level during their deposition. At present the shores along the Ayrshire coast are sinking.

The Post-drift, or as they were formerly known, the Post-tertiary, deposits of the West of Scotland were first investigated largely by the late James Smith of Jordanhill, whose numerous papers on the subject to the Wernerian Society and other bodies were begun in 1836. After his time the work was carried on by Dr. David Robertson and Rev. Dr. Crosskey amongst others, which resulted in the full account of the beds and their fossil remains published in the "Catalogue of the Western Scottish Fossils" in 1876, where a detailed description of many of the localities will also be found.

Since that time considerable additions have been made through the exhaustive work carried on at Garvel Park Dock, Greenock, and elsewhere in the area, with the result that the present may be taken as a fairly complete list of the organisms found in the low-level Post-drift beds of the Clyde area.

The Arctic shells and the recent species are distinguished as follows :—

* Arctic shells still living in British seas.
** Arctic shells now extinct in British seas.
† Recent mollusca of the Firth of Clyde and its sea-lochs.
(No localities are given for living species.)
(R-B.) Raised-Beach beds.

ALGAE.

Sphacelaria cirrhosa, *Ro.*—Gourock ; Garvel Park.
Dictyosyphon foeniculaceus, *Grev.*—Gourock ; Garvel Park.
Desmarestia aculeata, *Leyrx.*—Gourock ; Garvel Park.
Melobesia polymorpha, *L.*—Paisley ; Garvel Park ; Gourock ; Misk ; (R-B., Shewalton).
Corallina officinalis, *L.*—Paisley ; Garvel Park (R-B., Shewalton).
C. rubens, *L.*—Paisley.
Dictyota dichotoma, *Huds.*—Garvel Park.
Peyssonuelia Dubyi, *Cronan.*—Garvel Park.

MUSCI.

Gymnostomum.—	Garvel Park.
Dichodontium pellucidum, *Schimp.*	" "
Dicranum scoparium, *Hedw.*—	" "
Cynodontium virens, var. **compactum,** *Schimp.*—	" "
Distichium inclinatum, *Schimp.*—	" "
Trichostomum.—	" "
Barbula fragilis, *Schimp.*—	" "
B. tortuosa, *Web. Mohr.*—	" "
B. aciphylla.—	" "
Racomitrium lanuginosum, *Hedw.*—	" "
Webera albicana, *Wahl.*—	" "
Bryum pseudotriquetrum, *Hedw.*—	" "
B. palens, *Swartz.*—	" "
Mnium subglobosum, *B. & S.*—	" "
M. affine, *Bland.*—	" "
Paludella squarrosa, *Brid.*—	" "
Aulocomnium palustre, *Schw.*—	" "
Philonotis fontana, *Brid.*—	" "
Polytrichum juniperinum, *Willd.*—	" "
P. strictum, *Banks.*—	" "
Pogonatum curtipendula.—	" "
Antitrichia curtipendula, *Hook & Taylor.*—	" "
Climacium dendroides, *Lin.*—	" "
Thuidium tamariscinum, *Hedw.*—	" "
T. decipens, *De Not.*—	" "
Brachythecium rivulare, *B. & S.*—	" "
B. reflexum, *Web.*—	" "
B. populeum, *Hedw.*—	" "
B. salebrosum, *Hoffm.*—	" "
B. albicans, *Neck.*—	" "
Camptothecium nitens, *Schreb.*—	" "
C. lutescens, *Huds.*—	" "
Eurhynchium piliferum, *Schreb.*—	" "
Plagiothecum denticulatum, *Linn.*—	" "
Amblystegium.—	" "
Hypnum elodes, *Spruce.*—	" "
H. stellatum, *Schreb.*—	" "
H. giganteum, *Schreb.*—	" "

Polymorphina acuminata, *Will.*—Garvel Park.
P. lanceolata.—(R-B., Shewalton).
Reophax fusiformis, *Will.*—Garvel Park; Greenock.
Spirilina vivipara, *Ehr.*—Garvel Park.
Uvigerina pygmaea, *d'Orb.*—Kilchattan; Tangy Glen; Garvel Park.
Orbulina universa, *d'Orb.*—Jordanhill; Garnock Water; Garvel Park.
Globigerina bulloides, *d'Orb.*—Garvel Park; Jordanhill; Garnock Water; Tangy Glen; Misk.
Textularia sagittula, *Defr.*—Misk; Jordanhill; Dalmuir; (R-B., Cumbrae).
T. variabilis, *Will.*—Misk.
Verneuilina polystropha, *Reuss.*—Garvel Park; Kilchattan; Misk.
Pulvinulina canariensis, *d'Orb.*—Garvel Park.
Bulimina pupoides, *d'Orb.*—Kilchattan; Misk; (R-B., Largs).
B. marginata, *d'Orb.*—Misk; Garvel Park; (R-B., Shewalton).
B. elegantissima, *d'Orb.*—Garvel Park.
B. elegans, *d'Orb.*—(R-B., Shewalton).
B. ovata, *d'Orb.*—Misk; Garvel Park.
Bolivina punctata, *d'Orb.*—Garnock Water; Misk; Garvel Park.
B. costata, *d'Orb.*—Garvel Park.
Cassidulina laevigata, *d'Orb.*—Kilchattan; Lochgilp; Tangy Glen.
C. crassa, *d'Orb.*—Cumbrae Coll: Lochgilp; Garvel Park.
Virgulina squamosa, *d'Orb.*—Misk.
V. Schreibersiana, *Czizak.*—(R. B., Largs).
Discorbina rosacea, *d'Orb.*—Paisley; Garnock Water; Lochgilp; (R-B., Shewalton).
D. globularis, *d'Orb.*—Misk; Dipple; Tangy Glen; Garvel Park; (R-B., Shewalton).
D. Wrighti, *Brady.*—Garvel Park.
Planorbulina mediterranensis, *d'Orb.*—Misk; Garnock Water; Garvel Park; (R-B., Shewalton).
Truncatulina lobatula, *Walker.*—Dalmuir; Paisley; Garvel Park; Lochgilp; Misk; Kilchattan; Garnock Water: Tangy Glen; (R-B., Shewalton.)
Rotalia Beccari, *L.*—Paisley; Misk; Garvel Park; Garnock Water; Kyles of Bute; Kilchattan; Tangy Glen; (R-B., Shewalton).
R. nitida, *Will.*—Garvel Park.
R. orbicularis, *d'Orb.*—Lochgilp.
Gypsina inhaerans, *Shultze.*—(R-B., Shewalton).
Patellina corrugata, *Will.*—Paisley; Garvel Park.
Polystomella crispa, *L.*—Frequent in the glacial and Raised-Beach beds.
P. striato-punctata, *F. & M.*—Frequent in the glacial and Raised-Beach beds.
P. arctica, *J. & P.*—Kyles of Bute.
Nonionina asterizans, *F. & M.*—Tangy Glen; Garvel Park; Garnock Water; Cumbrae Coll: Kyles of Bute; Misk.
N. turgida, *Will.*—Kyles of Bute; Kilchattan; Lochgilp; Garvel Park.
N. depressula, *W. & J.*—Frequent in the glacial and Raised-Beach beds.
N. scapha, *L.*—Garvel Park.
N. stelligera, *d'Orb.*—Garvel Park.

PORIFERA.

Cliona celata, *Grant.*—Misk; Gourock; Garvel Park; Lochgilp; Old Mains; Paisley; (R-B., Cumbrae).
C. gorgonoides (R-B., Shewalton).
Spongia, spicules (R-B., Largs).

COELENTERATA.

Tubularia larnyx, *Ellis & Sol.*—Garvel Park.
Sphenotrochus Wrighti, *Gosse.*—Old Mains.

Eudendrium ramosum, *Ehr.*—Arklieston.
Paracyathus taxilianus; (R-B., Largs).
Sertularia pumila, *Doody.*—Garvel Park.
S. filicula, *Huds.*—Garvel Park.

ECHINODERMATA.

Ophiopholis aculeata, *L.*—Dalmuir; Paisley; Garvel Park.
Ophiura albida, *Forbes.*—Duntroon; Garvel Park; Kilchattan.
Strongylocentrotus dröbachiensis, *Mull.*—Frequent in the glacial beds.
Echinus esculentus, *Lin.*—Lochgilp; Garvel Park; Kilchattan; Gourock; (R-B., Shewalton; Cumbrae).
Echinocyamus pusillus, *Müll.*—(R-B., Largs).
Echinocardium cordatum, *Forbes.*—(R-B., Shewalton; Largs)
Psolus phantapus, *L.*—Houston; Bute; Garvel Park.

VERMES.

Sipunculus Bernhardus, ? *Forbes.*—Dalmuir.
Filograna implexa, *Berk.*—Garvel Park.
Serpula triquetra, *Mart.*—Dalmuir; Garvel Park; Stevenston; Lochgilp.
S. Alderi, *Robertson.*—Garvel Park.
S. vermicularis, *Ellis.*—Troon; Dalmuir; Lochgilp; Garvel Park; Gourock; Misk; Kilchattan; Jordanhill: Garnock Water; (R-B., Cumbrae).
Spirorbis carinatus, *Flem.*—Paisley.
S. communis, *Flem.*—Garvel Park; (R-B., Shewalton; Cumbrae).
S. nautiloides, *Lam.*—Dalmuir; Stevenston.
S. corrugatus, *Mont.*—Bute.
S. spirillum, *L.*—E. Tarbert: Duntroon; Paisley; Garvel Park; Arran; Gourock; Jordanhill; Misk.
S. Wattianus, *Scott.*—Garvel Park.

CRUSTACEA.

Cyclocypris globosa, *G. O. S.*—(R-B., Shewalton).
Potamocypris fulva, *Brady.*—Garvel Park; Dalmuir; (R-B., Shewalton).
Argilloecia cylindrica, *G. O. S.*—Garvel Park; Paisley; Garnock Water; Misk; Kilchattan.
Pontocypris mytiloides, *Nor.*—Garvel Park; Paisley; (R-B., Shewalton; Cumbrae).
P. trigonella, *G. O. S.*—Garvel Park; Paisley; Lochgilp.
Aglaia complanata, *Baird.*—(R-B., Largs).
Bairdia inflata, *Nor.*—(R-B., Largs).
Cythere confusa, *Baird.*—Frequent in the glacial beds; (R-B., Shewalton).
C. pellucida, *Baird.*—Frequent in the glacial beds.
C. porcellanea, *Brady.*—Dalmuir; Garvel Park; Garnock Water; Misk; Cumbrae Coll: Lochgilp; Kilchattan.
C. Macallana, *B. & R.*—Cumbrae Coll: Kilchattan; (R-B., Shewalton).
C. tenera, *Brady.*—Garnock Water; (R-B., Shewalton; Cumbrae).
C. deflexa, *B. C. & R.*—Jordanhill.
C. crispata, *Brady.*—Paisley (R-B., Shewalton; Largs).
C. lutea, *Müll.*—Frequent in the glacial and Raised-Beach beds.
C. albo-maculata, *Baird.*—Cumbrae Coll.; (R-B., Shewalton; Largs; Cumbrae).
C. convexa, *Baird.*—Paisley; Cumbrae Coll.; Lochgilp; (R-B., Shewalton; Cumbrae).
C. clutha, *B. C. & R.*—Garvel Park; Kilchattan.
C. finmarchica, *G. O. S.*—Lochgilp.
C. limicola, *Nor.*—Garvel Park; Cumbrae Coll.: Kyles of Bute; Tangy Glen; Misk; Kilchattan.

Cythere globulifera, *Brady.*—Jordanhill; Paisley; Tangy Glen.
C. cuneiformis, *Brady.*—(R-B., Shewalton.)
C. pulchella, *Brady.*—Jordanhill; Garnock Water; Cumbrae Coll.: Kilchattan; Lochgilp; (R-B., Shewalton); Cumbrae; Largs.
C. confusa, *B. and N.*—Garvel Park (R-B., Shewalton).
C. badia, *Nor.*—(R-B., Shewalton).
C. emaciata, *Brady.*—(R-B., Shewalton).
C. Jonesi, *Baird.*—(R-B., Shewalton).
C. villosa, *G. O. S.*—Frequent in the glacial and Raised-Beach beds.
C. concinna, *Jones.*—Frequent in the glacial beds.
C. quadridentata, *Baird.*—Lochgilp.
C. angulata, *G. O. S.*—Frequent in the glacial (and R-B.) beds.
C. tuberculata, *G. O. S.*—Frequent in the glacial beds.
C. emarginata, *G. O. S.*—Lag; Garvel Park; E. Tarbert; Misk (R-B., Shewalton).
C. costata, *Brady.*—Paisley.
C. mirabilis, *Brady.*—Lochgilp?
C. Dunelmensis, *Nor.*—Frequent in the glacial beds.
C. Robertsoni, *Brady.*—Lochgilp.
C. gibbosa, *B. & R.*—Garnock Water.
Cytheridea papillosa, *Bosq.*—Frequent in the glacial beds; (R-B., Cumbrae).
C. elongata, *Brady.*—(R-B., Shewalton; Largs).
C. punctillata, *Brady.*—Frequent in the glacial beds.
C. Sorbyana, *Jones.*—Tangy Glen; Garvel Park; Misk.
Eucythere declivis, *Nor.*—Frequent in the glacial beds; (R-B., Shewalton).
Krithe Bartonensis, *Jones.*—Duntroon.
K. glacialis, *B. C. and R.*—Garvel Park.
Loxoconcha impressa, *Baird.*—Misk; Garvel Park; Jordanhill; (R-B., Shewalton; Cumbrae).
L. tamarindus, *Jones.*—Frequent in the glacial beds.
L. fragilis, *G. O. S.*—Paisley; Garvel Park.
L. viridis, *Müll.*—Govan; (R-B., Shewalton).
Xestoleberis depressa, *G. O. S.*—Jordanhill; Paisley; Lochgilp (R-B., Shewalton).
X. aurantia, *Baird.*—Lochgilp; Garvel Park (R-B., Cumbrae).
Cytherura nigrescens, *Baird.*—Frequent in the glacial beds; (R-B., Shewalton; Cumbrae).
C. similis, *G. O. S.*—Dalmuir: Garvel Park; Cumbrae Coll.: Kyles of Bute, Kilchattan; E. Tarbert; (R. B., Shewalton).
C. pumila, *B. C. and R.*—Dalmuir; Garvel Park; Cumbrae Coll.
C. concentrica, *B. C. and R.*—Paisley.
C. undata, *G. O. S.*—Frequent in the glacial beds; (R-B., Largs; Shewalton).
C. striata, *G. O. S.*—Garvel Park; Garnock Water; Cumbrae Coll.: Kyles of Bute; Misk; Kilchattan; (R-B., Shewalton).
C. gibba, *Müll.*—Lochgilp; Jordanhill; Kilchattan; (R-B., Shewalton).
C. cellulosa, *Nor.*—Jordanhill; (R-B., Shewalton; Cumbrae).
C. clathrata, *G. O. S.*—Frequent in the glacial beds.
C. sella, *G. O. S.*—Garvel Park; Kyles of Bute; (R-B., Shewalton; Largs; Cumbrae).
C. acuticostata, *G. O. S.*—(R-B., Shewalton; Cumbrae; Largs).
C. producta, *Brady.*—(R-B., Largs).
C. angulata, *Brady.*—Misk; (R-B., Shewalton; Cumbrae; Largs).
C. fulva, *B. and R.*—(R-B., Shewalton; Largs).
C. cornuta, *Brady.*—Garnock Water; (R-B., Shewalton; Largs).
C. simplex, *Baird.*—(R-B., Largs).
Cytheropteron latissimum, *Nor.*—Jordanhill; Dalmuir; Old Mains; Paisley; E. Tarbert; Tangy Glen.

Cytheropteron arcuatum, *B. C. and R.*—Tangy Glen Garvel Park.

C. nodosum, *Brady.*—Jordanhill; Dalmuir; Garvel Park; Cumbrae Coll.; (R-B., Stewalton).

C. Montrosiense, *B. C. and R.*—Tangy Glen; Misk.

C. angulatum, *B. and R.*—Dalmuir; Garvel Park; Cumbrae Coll.; Kyles of Bute; (R-B., Largs).

C. inflatum, *Brady.*—Garvel Park.

Cytherois Fischeri, *G. O. S.*—(R-B., Shewalton).

Bythocythere simplex, *Nor.*—Jordanhill; Dalmuir; Paisley; Garvel Park; Misk.

B. constricta, *G. O. S.*—Tangy Glen; Misk.

B. elongata, *B. C. and R.*—Govan.

Pseudocythere caudata, *G. O .S.*—Dalmuir; E. Tarbert.

Sclerochilus contortus, *Nor.*—Frequent in the glacial beds.

Paradoxostoma variable, *Baird.*—Frequent in the glacial beds.

P. abbreviatum, *G. O. S.*—Lochgilp.

P. ensiforme, *Brady.*—Garnock Water; Kyles of Bute (R-B., Shewalton; Cumbrae).

P. Fischeri, *G. O. S.*—Garvel Park; Garnock Water.

P. flexuosum, *Brady.*—Lochgilp; Misk; (R-B., Shewalton).

P. tenerum, *B. C. and R.*—Dalmuir; Garvel Park.

P. obliquum, *G. O. S.*—(R-B., Shewalton).

Asterope teres, *Nor.*—Jordanhill.

Polycope orbicularis, *G. O. S.*—Dalmuir; Old Mains; Paisley; Garvel Park; Misk.

Bosquetia robusta, *B. C. and R.*—Paisley.

Hyas araneus, *Fabr.*—Garvel Park; (R-B., Cumbrae).

Cancer pagurus.—Garvel Park.

Eupagurus sp.—Garvel Park.

Galathea sp.—Garvel Park.

Balanus balanoides, *L.*—Paisley; Garvel Park; Windmillcroft; Dalmuir; Jordanhill; Misk; (R-B., Cumbrae).

B. crenatus, *Brug.*—Frequent in the glacial beds; (R-B., Cumbrae).

B. Hameri, *Ascanius,* Lochgilp; Old Mains; Garvel Park.

B. porcatus, *Da Costa.*—Frequent in the glacial beds; (R-B., Cumbrae).

B. porcatus, var **elongata ?**—Garvel Park.

B. cariosus, *Darwin.*—Kyles of Bute.

Verruca strömia, *Mull.*—Frequent in the glacial beds; (R-B., Shewalton).

POLYZOA.

Menipea ternata, *Ellis and Sol.*—Garvel Park; Misk.

Cellularia Peachi, *Busk.*—Garvel Park.

C. reptans, *L.*—Duntroon; Paisley; Misk.

Scrupocellaria scruposa, *L.*—Garvel Park.

S. reptans, *L.*—Garvel Park.

S. scabra, var. **elongata,** *Smith.*—Garvel Park; (R-B., Shewalton).

Hippothoa catenularia, *Jam.*—Dalmuir; Duntroon.

Caberea Ellisi, *Flem.*—Garvel Park.

Bugula avicularia, *Pallas*—Duntroon.

Membranipora Flemingi, *Busk.*—Garvel Park; Lochgilp.

M. lineata, *L.*—Garvel Park.

M. tuberculata, *Busk.*—Garvel Park.

M. unicornis, *Blain.*—Garvel Park; Paisley; Dalmuir; Duntroon.

M. craticula, *Alder.*—Paisley; Misk.

Lepralia Peachi, *Johnston.*—Garvel Park; Cumbrae Coll.; Misk.

L. concinna, *Busk.*—Garvel Park; Lochgilp.

L. annulata, *Fabr.*—Garvel Park.

Lepralia hyalina, *L.*—Garvel Park.
L. verrucosa, *Esper.*—Dalmuir ; Duntroon ; Garvel Park.
L. crystallina, *Nor.*—Garvel Park.
L. spinifera, *Johnston.*—Dalmuir.
L. cruenta, *Nor.*—Garvel Park.
Porina tubulosa, *Nor.*—Garvel Park ; Misk.
Schizoporella sinuosa, *Busk.*—Garvel Park.
Eschara patens, *Smitt.*—Garvel Park.
E. struma, *Nor.*—Garvel Park.
Smittia Landsborovi, *Johns.*—Garvel Park.
Escharoides Sarsi, *Smitt.*—Garvel Park.
Crisia eburnea, *L.*—Frequent in the glacial beds ; (R-B., Shewalton).
Idmonea atlantica, *Forbes.*—Garvel Park.
Tubulipora flabellaris, *Fabr.*—Dalmuir.
T. phalangea, *Conch.—Dalmuir* ; Duntroon ; Garvel Park.
T. serpens, *L.*—Dalmuir ; Garvel Park.
Diastopora obelia, *Flem.*—Garvel Park.
Discoporella hispida, *Flem.*—Paisley.
D. grignoniensis, *Busk.*—Dalmuir ; Duntroon ; Misk.
D. flosculus, *Hincks.*—Garvel Park.
D. radiata, *Busk.*—Garvel Park.

MOLLUSCA.

Rhynchonella psittacea, *Chem.*—Ayrshire.
† **Terebratula caput-serpentis**, *L.*—Ayrshire.
† **Crania anomala**, *Müll.*
† **Anomia ephippium**, *L.*—Frequent in the glacial beds ; (R-B., Shewalton).
A. ephippium, var. **aculeata**, *L.*—Frequent in the glacial beds ; (R-B., Shewalton).
A. ephippium, var. **squamula**, *L.*—Garvel Park ; Paisley ; Lochgilp.
A. patelliformis, *L.*—Stevenston.
† **Ostrea edulis**, *L.*—(R-B., Shewalton ; Cumbrae).
* * **Pecten islandicus**, *Müll.*—Common in the glacial beds.
* * **P. groenlandicus**, *Lam.*—(R-B., Shewalton).
† **P. maximus**, *L.*—Garvel Park ; Troon ; (R-B., Shewalton ; Cumbrae).
† **P. striatus**, *Müll.*
† **P. opercularis**, *L.*—Lucknow ; Kyles of Bute ; Arran ; (R-B., Shewalton ; Largs ; Cumbrae).
† **P. pusio**, *L.*—Dalmuir.
† **P. septemradiatus**, *Müll.*—Loch Lomond ; R-B., Shewalton).
† **P. varius**, *L.*—Dalmuir.
† **P. similis**, *Lask.*—Tarbert.
† **P. tigrinus**, *Müll.*—Loch Lomond.
† **P. striatus**, *Müll.*
† **Lima hians**, *Gmel.*—(R-B., Cumbrae ; Largs).
† **L. elliptica**, *Jeff.*
† **L. subauriculata**, *Mont.*
† **L. Loscombi**, *G.B. Sow.*
* † **Mytilis edulis**, *L.*—Frequent in the glacial and Raised-Beach beds.
* † **M. modiolus**, *L.*—Frequent in the glacial and Raised-Beach beds.
† **M. phaseolinus**, *Phill.*
† **Modiolaria discors**, *L.*—Paisley.
M. laevigata, *Gray.*—Dalmuir ; Garvel Park.
M. nigra, *Gray.*—Garvel Park ; Kyles of Bute.
† **M. marmorata**, *Forbes.*
† **Crenella decussata**, *Mont.*
Dacrydium vitreum, *For.*—Garvel Park.

† **Nucula nitida,** *G.B. Sow.*—Paisley ; Garvel Park ; (R-B., Largs).
† **N. tenuis** *Mont.*—Frequent in the glacial beds.
N. tenuis, var. **expansa,** *Reeve.*—Cumbrae College.
N. tenuis, var. **inflata,** *Mörch.*—Paisley ; Garvel Park.
N. nucleus, *L.*—Paisley ; Lochgilp.
N. nucleus, var. **tumidula,** *Malm.*—Paisley.
N. nucleus, var. **radiata,** *F. and H.*—Garvel Park.
* * **Leda pernula,** *Müll.*—Common in the glacial beds.
L. pernula, var. **mucilenta,** *Steenst.*—Troon ; Garvel Park ; Paisley ; Kilchattan ; Gourock.
* **L. pygmaea,** *Münst.*—Frequent in the glacial beds.
L. pygmaea, var. **gibbesa,** *Smith.*—Cumbrae College.
L. pygmaea, var. **lenticulata,** *Müll.*—Garvel Park ; Paisley ; Kilchattan.
* * **L. arctica,** *Gray.*—Lucknow ; Troon ; Garvel Park.
L. limata, *Say.*—Garvel Park.
* † **L. minuta,** *Müll.*—Bute.
† **L. frigida,** *Torell.*—Garvel Park.
* **Pectunculus glycymeris,** *L.*—(R-B., Shewalton).
† **Lopton nitidum,** *Turt.*—Garvel Park ; Lochgilp ; (R-B., Shewalton ; Largs).
† **Montacuta bidentata,** *Mont.*—Garvel Park ; Gourock ; Dalmuir ; (R-B., Shewalton).
† **M. elevata,** *Stimp.*—Lochgilp ; Tangy Glen.
† **M. ferruginosa,** *Mont.*—Kilchattan ; (R-B., Shewalton).
† **M. substriata,** *Mont.*
† **Lucina borealis,** *L.*—Troon ; Garvel Park ; (R-B., Shewalton ; Largs ; Cumbrae).
L. spinifera, *Mont.*—(R-B., Shewalton).
† **Axinus flexuosus,** *Mont.*—Frequent in the glacial beds ; (R-B., Largs ; Shewalton).
A. flexuosus, var. **Gouldii,** *Phill.*—Paisley ; Lochgilp ; Garvel Park ; Kyles of Bute ; Kilchattan.
† **A. ferruginosa,** *Forbes.*
† **Cyamium minutum,** *Fabr.*—Garvel Park ; (R-B., Shewalton ; Largs).
† **Cardium norvegicum,** *Speng.*—Stevenston ; Garvel Park ; Lucknow ; Cumbrae College ; (R-B., Shewalton ; Cumbrae).
C. fasciatum, *Mont.*—Frequent in the glacial beds ; (R-B., Shewalton).
† **C. exiguum,** *Gmelin.*—Dalmuir ; Garvel Park ; Bute ; (R-B., Shewalton).
† **C. nodosum,** *Turt.*—(R-B., Shewalton).
* † **C. edule,** *L.*—Frequent in the glacial beds ; (R-B., Shewalton).
† **C. echinatum,** *L.*—Frequent in the glacial beds.
† **C. aculeatum,** *L.*—Stevenston.
† **C. minimum,** *Phill.*
† **Isocardia cor,** *L.*
Axinopsis orbiculata, *G. O. S.*—Garvel Park.
* † **Cyprina islandica,** *L.*—Common in the glacial beds ; (R-B., Shewalton).
* † **Astarte sulcata,** *Da Costa.*—Garvel Park ; Old Mains ; Paisley ; Lochgilp ; Kyles of Bute ; Troon.
A. triangularis, *Mont.*—Garvel Park.
* † **A. elliptica,** *Brown.*—Garvel Park ; Dalmuir ; Lochgilp ; Croftamie Troon ; Misk.
* † **A. compressa,** *Mont.*—Common in the glacial beds.
A. compressa, var. **globosa,** *Mull.*—Garvel Park ; Paisley.
A. compressa, var. **striata,** *Mull.*—Paisley ; Garvel Park.
* * **A. borealis,** *Chem.*—Frequent in the glacial beds.
A. crebricostata, *Forbes.*—Dalmuir ; Bute ; Garvel Park.
† **Circe minima,** *Mont.*—(R-B., Largs).

†**Venus ovata**, *Penn.*—Tangy Glen; (R-B., Cumbrae).
†**V. exoleta**, *L.*—Lucknow; (R-B., Shewalton; Largs; Cumbrae).
†**V. casina**, *L.*—Garvel Park; (R-B., Shewalton; Largs).
†**V. fasciata**, *Da Costa.*—Lucknow; (R-B., Shewalton; Largs; Cumbrae).
†**V. gallina**, *L.*—(R-B., Shewalton; Cumbrae; Largs).
†**V. lincta**, *Pult.*—Dalmuir; (R-B., Shewalton).
†**V. verrucosa**, *L.*
†**Tapes virgineus**, *L.*—Garnock Water; Kyles of Bute; (R-B., Shewalton; Largs).
†**T. pullastra**, *Mont.*—(R-B., Shewalton; Cumbrae).
†**T. decussatus**, *L.*—(R-B., Shewalton; Cumbrae).
†**T. aureus**, *Gmel.*—(R-B., Cumbrae).
†**Lucinopsis undata**, *Penn.*—Garvel Park.
****Tellina calcarea**, *Chemn.*—Common in the glacial beds.
*†**T. balthica**, *L.*—Garvel Park; Dalmuir; Old Mains; Paisley; Girvan; (R-B., Shewalton; Cumbrae).
†**T. donacina**, *L.*—(R-B., Shewalton).
†**T. crassa**, *Gmel.*—(R-B., Shewalton; Cumbrae).
†**T. fabula**, *Grön.*—Garvel Park; Lochgilp; (R-B., Shewalton).
T. squalida, *Pult.*—Dalmuir; Kyles of Bute; (R-B., Shewalton).
T. groenlandica, *Beck.*—Bute.
†**T. tenuis**, *Da Costa.*—Kyles of Bute; (R-B., Shewalton).
†**Psammobia tellinella**, *Lam.*—(R-B., Shewalton).
†**P. costulata**, *Turt.*
†**P. ferroensis**, *Chemn.*—Garvel Park; Kyles of Bute.
†**P. vespertina**, *Chemn.*—(R-B., Shewalton).
†**Donax vittatus**, *Da Costa.*—Ayr; (R-B., Shewalton).
Mactra solida, *L.*—Garvel Park; Kyles of Bute; Stevenston.
†**M. solida**, var. **elliptica**, *Brown.*—Duntroon.
†**M. subtruncata**, *Da Costa.*—Cumbrae College; Kilchattan; Troon; (R-B., Shewalton; Cumbrae).
M. subtruncata, var. **striata**, *Brown.*—Dalmuir; (R-B., Shewalton).
†**M. stultorum**, *L.*—(R-B., Shewalton).
†**Lutraria elliptica**, *Lam.*—Kyles of Bute; Lucknow; (R-B., Shewalton).
†**Scrobicularia alba**, *Wood.*—Dalmuir; Lochgilp; Garvel Park; Gourock; Garnock Water.
†**S. prismatica**, *Mont.*—Lochgilp; Kilchattan; Troon; Misk; Garvel Park
†**S. piperata**, *Bellon.*—(R-B., Shewalton).
†**Solen ensis**, *L.*—Garvel Park; (R-B., Shewalton: Cumbrae).
†**S. siliqua**, *L.*—(R-B., Shewalton; Cumbrae; Largs).
†**S. pellucidus**, *Penn.*
†**Lyonsia arenosa**, *Möll.*—Garvel Park.
†**L. norvegica**, *Chemn.*
†**Thracia myopsis**, *Beck.*—Greenock.
†**T. distorta**, *Mont.*
†**T. papyracea**, *Poli.*—Garvel Park; Kyles of Bute; Lochgilp; (R-B., Shewalton).
T. truncata, *Brown.*—Garvel Park.
†**T. praetenuis**, *Pult.*—Garvel Park.
†**T. pubescens**, *Pult.*
†**T. convexa**, *Wood.*
†**T. septentrionalis**, *Jeff.*—Garvel Park.
†**Corbula gibba**, *Olivi.*—Garvel Park; E. Tarbert; Tangy Glen.
Neaera subtorta, *G. O. S.*—Garvel Park.
†**N. abbreviata**, *Fort.*
†**N. costellata**, *Desh.*
†**N. cuspidata**, *Olivi.*

*† **Mya truncata,** *L.*—Common in the glacial beds.

** **M. truncata,** var. **uddevallensis**—Dalmuir ; Lochgilp ; Kyles of Bute.

† **M. arenaria,** *L.*—Garvel Park ; Lochgilp ; Bute.

Saxicava (Panopoea) norvegica, *Speng.*—Kyles of Bute ; Fairlie ; Langbank ; Garvel Park ; Gourock.

*† **S. rugosa,** *L.*—Frequent in the glacial beds ; (R-B., Shewalton).

S. rugosa, var. **arctica,** *L.*—Jordanhill ; Garvel Park ; Kyles of Bute ; Dalmuir ; Lochgilp ; E. Tarbert.

S. rugosa, var. **praecisa,** *Mont.*—Lochgilp.

S. rugosa, var. **sulcata,** *Smith.*—Paisley ; Rothesay ; Kyles of Bute.

S. pholades, *Jeff.*—Garvel Park.

† **Panopoea plicata,** *M. de la Groge.*

† **Pholas crispata,** *L.*—Cumbrae ; Garvel Park ; Kilchattan ; Stevenston ; (R-B., Shewalton ; Cumbrae).

P. dactylus, *L.*—Stevenston ; (R-B., Shewalton).

† **P. candida,** *L.*—(R-B., Shewalton).

† **Xylophaga dorsalis,** *Tur.*—(R-B., Shewalton).

† **Teredo norvegica,** *Speng.*—(R-B., Shewalton).

† **T. megotara,** *Han.*

*† **Dentalium entalis,** *L.*

Gasteropoda.

† **Chiton marmoreus,** *Fabr.*—Garvel Park ; Dalmuir ; Old Mains ; Lochgilp ; Misk ; Garnock Water.

† **C. ruber,** *L.*—Garvel Park ; Dalmuir ; Lochgilp.

† **C. cinereus,** *L.*—Garvel Park ; Lochgilp.

† **C. fasicularis,** *L.*

† **C. marginatus,** *Penn.*

† **C. laevis,** *Fab.*

† **Patella vulgata,** *L.*—Lucknow ; (R-B., Shewalton ; Cumbrae).

† **Helcion pellucidum,** *L.*—Garnock Water ; Garvel Park ; Lochgilp ; Dalmuir ; (R-B., Shewalton ; Cumbrae).

† **H. pellucidum,** var. **laevis,** *Penn.*—Dalmuir.

† **Tectura virginea,** *Mull.*—Garvel Park ; Dalmuir ; Old Mains ; Paisley ; Garnock Water ; Kyles of Bute ; Kilchattan ; Lochgilp ; Gourock ; Misk.

† **T. testudinalis,** *Müll.*

† **T. fulva,** *Müll.*

† **Puncturella Noachina,** *L.*—Frequent in the glacial beds.

† **Propilidium ancyloides,** *F. & H.*

† **Fissurella graeca,** *L.*—Clyde beds.

† **Emarginula fissura,** *L.*—(R-B., Cumbrae).

E. crassa, *J. Sow.*

† **Capulus hungaricus.** *L.*

Cyclostrema costulata, *Möll.*—Paisley.

† **Trochus helicinus,** *Fabr.*—Frequent in the glacial beds ; (R-B., Shewalton).

† **T. groenlandicus,** *Chemn.*—Frequent in the glacial beds.

T. lineatus, *Da Costa.*—(R-B., Cumbrae). [Shell-mound, Ardrossan.]

† **T. tumidus,** *Mont.*—Frequent in the glacial beds ; (R-B., Shewalton ; Largs).

T. Vahlii, *Möll.*—Paisley ; Garvel Park.

T. cinereus, *Couth.*—Clyde Beds :—glacial.

† **T. cinerarius,** *L.*—Lochgilp ; Garvel Park ; Kilchattan ; Garnock Water ; Lucknow ; (R-B., Shewalton ; Cumbrae ; Largs).

† **T. millegranus,** *Phill.*—Clyde Beds.

† **T. magus,** *L.*—Clyde Beds ; (R-B., Shewalton ; Cumbrae ; Largs).

† **T. umbilicatus,** *Brod. & Sow.*—Garvel Park ; (R-B., Shewalton).

Trochus nitens, *Phill.*
† **T. Montacuta**, *W. Wood.*
† **T. zizyphinus**, *L.*
Molleria costulata, *Möll.*—Misk ; Garvel Park ; (R-B., Shewalton).
Margarita cinerea, *Couth.*—Bute ; Rothesay.
M. olivacea, *Brown.*—Clyde Beds.
† **Lacuna divaricata**, *Fabr.*—Frequent in the glacial beds ; (R-B., Shewalton ; Cumbrae ; Largs).
L. divaricata, var. **quadrifasciata**, *Moulf.*—Dalmuir.
L. puteolus, *Turt.*—Dalmuir : Paisley ; Garvel Park ; Cumbrae Coll. ; (R-B., Shewalton).
L. pallidula, *Da Costa.*—Lochgilp ; Dalmuir ; (R-B., Cumbrae).
var. **neritoidea**, *Gould.*—Dalmuir.
† **Littorina littorea**, *L.*—Common in the glacial and Raised-Beach beds.
† **L. rudis**, *Maton.*—Common in the glacial (and R-B.) beds.
† **L. rudis**, var. **saxatilis**, *John.*—Garvel Park ; (R-B., Shewalton).
† **L. rudis**, var. **patula**, *Jeff.*—Dalmuir ; Bute ; Troon.
† **L. obtusata**, *L.*—Frequent in the glacial beds ; (R-B., Cumbrae).
L. obtusata, var. **neritiformis**, *Brown.*—E. Tarbert.
L. limata, *Lovén.*—Jordanhill ; Garvel Park ; Dalmuir ; E. Tarbert ; Misk ; Paisley ; Lochgilp.
L. squalida, *Brod. and Sow.*—Paisley.
† **L. neritoides**, *L.*—
† **Rissoa violacea**, *Desm.*—Lochgilp ; (R-B., Shewalton ; Cumbrae).
R. violacea, var. **ecostata**, *Jeff.*—(R-B., Shewalton).
† **R. striata**, *Adams.*—Frequent in the glacial (and R-B.) beds.
R. striata, var. **arctica**, *Loven.*—Garvel Park ; Paisley.
R. lactea, *Mich.*—(R-B., Shewalton).
† **R. parva**, *Da Costa.*—Garvel Park ; Duntroon ; Paisley ; (R-B., Shewalton ; Cumbrae).
R. parva, var. **interrupta**, *Adams.*—Frequent in the glacial beds ; (R-B., Shewalton).
† **R. abyssicola**, *Forbes.*—(R-B., Shewalton).
† **R. soluta**, *Phill.*—Paisley ; (R-B., Shewalton).
R. inconspicua, *Alder.*—Jordanhill ; (R-B., Shewalton).
R. inconspicua, var. **ventrosa**, *Mont.*—Dalmuir.
† **R. cingillus**, *Mont.*—Dalmuir ; (R-B., Largs).
† **R. membranacea**, *Adams.*—Bute ; (R-B., Shewalton ; Largs).
R. membranacea, var. **minor**, *Jeff.*—(R-B., Shewalton).
** **R. arenaria**, *M. and A.*—Garvel Park.
† **R. reticulata**, *Mont.*—Lochgilp ; Paisley ; Garvel Park ; (R-B., Shewalton : Cumbrae).
† **R. cancellata**, *Da Costa.*—Lochgilp.
† **R. striatula**, *Mont.*—Lochgilp ; (R-B., Shewalton ; Largs).
R. costata, *Adams.*—Garvel Park ; Largs ; (R-B., Shewalton ; Cumbrae).
† **R. punctura**, *Mont.*—(R-B., Shewalton).
† **R. calathus**, *F. and H.*
† **R. vitrea**, *Mont.*—(R-B., Largs).
† **R. fulgida**, *Adams.*—
† **R. zetlandica**, *Mont.*—
† **Barleeia rubra**, *Mont.*
Menestho albula, *Fabr.*—Paisley.
† **Hydrobia ulvae**, *Penn.*—Dalmuir ; Garvel Park ; Paisley ; (R-B., Shewalton ; Cumbrae).
† **Jeffreysia opalina**, *Jeff.*
† **J. diaphana**, *Jeff.*
† **Skenea planorbis**, *Fabr.*—Frequent in the glacial (and R-B.) beds.

† **Homalogyra atomus**, *Phill.*—Frequent in the glacial beds (R-B., Largs; Shewalton).
† **H. rota**, *T. and H.*—(R-B., Shewalton).
† **Turritella terebra**, *L.*—(R-B., Shewalton; Cumbrae).
† **Caecum trachea**, *Mont.*—(R-B., Shewalton; Cumbrae).
† **C. glabrum**, *Mont.*—(R-B., Shewalton; Cumbrae; Largs).
† **Scalaria communis**, *Lam.*—(R-B., Shewalton; Cumbrae).
S. groenlandica, *Chemn.*—Fairlie.
† **S. Turtonae**, *Turt.*
† **Cioniscus (alcis) unicus**, *Mont.*—(R-B., Shewalton).
Odostomia unidentata, *Mont.*—Lochgilp; Garvel Park; Kilchattan; Misk.
† **O. rissoides**, *Han.*—(R-B., Shewalton).
† **O. turrita**, *Hanley*—Lochgilp; (R-B., Shewalton).
O. plicata, *Mont.*—(R-B., Shewalton).
† **O. spiralis**, *Mont.*—Lochgilp; Dalmuir; Garvel Park; (R-B., Shewalton; Cumbrae).
O. lukisi, *Jeff.*—Garvel Park.
† **O. decussata**, *Mont.*—(R-B., Shewalton; Largs).
† **O. conoidea**, *Brocchi.*—Lochgilp.
† **O. pallida**, *Mont.*—Lochgilp.
O. pusilla, *Phill.*—(R-B., Shewalton).
O. nitida, *Ald.*—(R-B., Shewalton).
† **O. scalaris**, *Phill.*
† **O. excavata**, *Phill.*—(R-B., Largs).
† **O. rufa**, *Phill.*—
† **O. acicula**, *Phill.*—
† **O. nivosa**, *Mont.*—
† **O. conspicua**, *Alder.*—
† **O. insculpta**, *Mont.*—
† **O. obliqua**, *Alder.*—
† **O. indistincta**, *Mont.*—
† **O. interstincta**, *Mont.*—
† **O. nitidissima**, *Mont.*—
† **Eulima distorta**, *Desh.*—Misk; (R-B., Largs).
† **E. polita**, *L.*
† **E. bilineata**, *Alder.*—(R-B., Largs).
† **Natica affinis, (clausa)** *Gmelin.*—Frequent in the glacial beds.
† **N. catena**, *Da Costa.*—Dalmuir; (R-B., Shewalton; Cumbrae).
† **N. groenlandica**, *Bick.*—Frequent in the glacial beds.
† **N. pallida**, *Brod. and Sow.*—Dalmuir; Paisley; Kilchattan.
† **N. Alderi**, *Forbes.*—(R-B., Shewalton; Cumbrae).
† **N. Montacuta**, *Forbes*, Clyde Beds; (R-B., Shewalton).
† **N. Smithi**, *Brown*, Ardencaple.
† **N. sordida**, *Phill.*—Troon.
† **Adeorbis subcarinata**, *Mont.*
† **Velutina laevigata**, *Penn.*—Garvel Park; Dalmuir; Kilchattan.
** **V. undata**, *Smith*—Garvel Park; Dalmuir; Old Mains; Paisley; Garnock Water; Girvan.
† **Lamellaria perspicua**, *L.*
† **Trichotropis borealis**, *Brod. and Sow.*—Garvel Park; Kyles of Bute.
† **Aporrhais pes-pelicani**, *L.*—Garvel Park; Kilchattan; Gourock; (R-B., Shewalton; Cumbrae).
† **Cerithium reticulatum**, *Da Costa.*—Garvel Park; Cumbrae Coll: Lochgilp; Duntroon; Garnock Water; (R-B., Shewalton; Cumbrae).
† **Triforis perversa**, *L.*—Garvel Park; (R-B., Shewalton; Cumbrae; Largs).
† **Cerithiopsis tuberculata**, *Mont.*

*† **Purpura lapillis**, *L.*—Frequent in the glacial; (and R-B.) beds.
Buccinum groenlandicum, *Chem.*—Old Mains; Paisley; Gourock Water; Gravel Park.
*† **B. undatum**, *L.*—Common in the glacial; (and R-B.,) beds.
B. ciliatum, *Forbes.*—Bute.
Murex erinaceus, *L.*—Dalmuir.
** **Trophon clathratus**, *L.*—Frequent in the glacial beds.
T. clathratus, var. **Gunneri**, *Lovén.*—Frequent in glacial beds.
† **T. truncatus**, *Ström.*—Frequent in the glacial beds.
*† **Fusus antiquus**, *L.*—Frequent in the glacial beds.
† **F. gracilis**, *Da Costa.*—Dalmuir; Girvan; (R-B., Cumbrae).
F. propinquus, *Alder.*—Lochgilp.
F. despectus, *L.*—Dalmuir.
F. barvicensis, *John.*—Garvel Park.
† **Nassa incrassata**, *Ström.*—Kyles of Bute; Lochgilp; Troon; (R-B., Cumbrae).
† **N. reticulata**, *L.*—(R-B., Shewalton; Cumbrae).
† **N pygmaea**, *Lam.*
† **Defrancia linearis**, *Mont.*—Garvel Park.
† **D. purpurea**, *Mont.*—(R-B., Shewalton).
† **D. teres**, *Forb.*
† **D. gracilis**, *Mont.*
† **D. Leufroyi**, *Michand.*
Pleurotoma pyramidalis, *Ström.*—Frequent in the glacial beds.
P. rufa, *Mont.*—(R-B., Cumbrae).
*† **P. turricula**, *Mont.*—Frequent in the glacial beds.
P. violacea, *Migh. and Ad.*—Frequent in the glacial beds.
P. costata, *Don.*—(R-B., Cumbrae).
† **P. septangularis**, *Mont.*—(R-B., Cumbrae).
† **P. nebula**, *Mont.*—(R-B., Shewalton).
† **P. striolata**, *Phill.*—(R-B., Cumbrae).
P. Trevelyana, *Turt.*—Kilchattan; Garvel Park; Garnock Water; (R-B., Cumbrae).
† **Cypraea europaea**, *Mont.*—Garvel Park; (R-B., Shewalton; Cumbrae; Largs).
Cylichna alba, *Brown.*—Dalmuir; Lochgilp; Duntroon; Paisley; Kyles of Bute; Garnock Water; Garvel Park.
† **C cylindracea**, *Penn.*—Paisley; Garvel Park.
C. obstricta, *Gould.*—Dalmuir; Lochgilp.
† **C. umbilicata**, *Mont.*
† **C. nitidula**, *Lovén.*
Utriculus hyalinus, *Turt.*—Dalmuir; Cumbrae Coll; Duntroon; Paisley; Garvel Park; Kilchattan.
† **U. obtusus**, *Mont.*—Frequent in the glacial beds; (R-B., Shewalton).
var. **turrita**, *Möll.*—Garvel Park.
† **V. truncatulus**, *Brug.*—Garvel Park; Duntroon; (R-B., Shewalton, Largs).
† **U. mammillatus**, *Phill.*—Garvel Park; Dalmuir; Arklieston; (R-B., Shewalton).
† **Bulla utriculus**, *Brocchi.*—Garvel Park.
† **Actaeon tornatilis**, *L.*
† **Scaphander lignarius**, *L.*—Greenock.
† **Philine scabra**, *Möll.*—Garvel Park.
† **P. lima**, *Brown.*—Garvel Park.
P. nitida, *Jeff.*—Garvel Park.
† **P. aperta**, *L.*—Garvel Park.
† **P. catena**, *Mont.*

† **Philine punctata**, *Clark.*
† **P. pruinosa**, *Clark.*
† **Aplysia punctata**, *Cuvier.*
† **Pleurobranchus plumula**, *Mont.*
† **Runcina Hancocki**, *Forbes.*
† **Melampus bidentatus**, *De Mont.*
† **Otina otis**, *Turt.*
Helix rotundata, *Mull.*—(R-B., Shewalton).
Vertigo edentula, *Drap.*—Garvel Park.
Cochlicopa lubrica, *O. F. Müll.*—Garvel Park.
C. tridens.—Misk ; (R-B., Shewalton).
Pupa marginata, *Drap.*—Garvel Park ; (R-B., Cumbrae).
Carychium minimum, *Müll.*—(R-B., Largs).

PTEROPODA.

Spirialis retroversus, *Flem.*—(R-B., Largs.)

PISCES.

Vertebrae and otolites.—Old Mains ; Garvel Park ; Lochgilp ; Gourock ; (R-B., Largs).

AVES.

Bones.—Paisley ; Dalmuir ; Garvel Park.

MAMMALIA.

(*a*) *Under Boulder-clay.*
Cervus tarandus, *L.*—Woodhill near Kilmaurs ; Croftamie, Dumbartonshire (*Proc. Roy. Phys. Soc. Edin.*, vol. i., 18—, p. 247).
Elephas primigenius, *Blum.*—Chapelhall, in stratified sand 350 feet above sea-level. Woodhill ; Drummuir near Dreghorn, under 76 feet of Boulder-clay.
(*b*) *In Boulder-clay.*
Cervus tarandus, *L.*—Raes Gill, Carluke.
Elephas primigenius, *Blum.*—Bishopbriggs. (A molar was got in a 45 feet sand-bed, 33 feet from the surface, at Baillieston. This bed rested on Coal-measure strata.)
(*c*) *Above Boulder-clay.*
Bos primigenius, *Bojanus.*—In the Clyde at Jordanhill, in clay ; Rothesay Bay ; Cowdenglen, in peat ; Greendyke Street, Glasgow, in silt.
B. longifrons, *Owen.*—Rutherglen Loan, Glasgow, in sand and gravel.
Cervus tarandus, *L.*—In the Clyde at Jordanhill.
Megaceros Hibernicus, Owen.—Cowdenglen in peat 15 feet from surface ; Maybole, in peat.
Equus caballus, *L.*—Cowdenglen ; (R-B., Shewalton).
Whale, a number of bones and two skulls got near the base of the 40 feet Raised-Beach bed at Shewalton.

Vertebrata from Caves and Shell Mounds, which may have been contemporaneous with the last Raised-Beach beds.

Excavations made in the Shell-mound, Ardrossan, and at Cleaves Cove, Dalry, resulted in the discovery of the remains of the following animals. For further information on the subject see papers by the author in the *Transactions of the Geological Society of Glasgow*, vol. vii., p. 284; vol. ix., p. 355; and his "Prehistoric Man in Ayrshire."

Homo sapiens, broken bones.*
Long-faced Ox.*
Goat.*
Dog or Wolf.*
Slender-legged Sheep.*
Red Deer.*
Pig.*
Badger.*
Rabbit.
Roebuck.
Hare.*
Fox.
Horse.
Otter.
Cat.
Beaver.*
Weasel.
Seal.
? Cetacean.*
Goose.*
Oyster Catcher.
Red Grouse.
Herring Gull.
Razorbill.
Puffin.
Guillemot.
Conger.
Cod.

*** Found at Cleaves Cove as well as Ardrossan.**

LOCALITIES OF POST-DRIFT FOSSILS[1] IN THE CLYDE DRAINAGE AREA.

Adamton, near Monkton.
Ardencaple, near Helensburgh.
Ardmarnock, Loch Fyne, in sandy, grey clay.
Arkleston, near Paisley, railway cutting.
Baillieston, near Glasgow.
Balnakaile Bay, Bute.
Bogside, near Irvine, in pit, muddy sand.
Bute, Island of, Balnakaile Bay, Kilchattan, Rothesay, etc.
Campbeltown, Tangy Glen, near.
Carluke, Raes Gill, near.
Cartsdyke, Greenock, in laminated clay.
Cleaves Cove, near Dalry, cave deposit.
Colintraive, Kyles of Bute, shore sections.
College, Great Cumbrae, in sand.
Cowdenglen, near Neilston.
Crinan Canal, in clay.
Cumbrae, Island of Great, at the College.
Dalmuir, burn section in sandy clay, or Boulder-clay.
Dipple Tilework, near Girvan, in clay.
Drummuir, near Dreghorn.
Dumbarton, in clay.
Duntroon, Loch Gilp, in clay or Boulder-clay.
East Tarbert, in clay.
Ettrick Bay, Bute.
Fairfield, *see* Govan.
Fairlie, Largs, shore sections, in sand and clay.
Garvel Park Dock, Greenock section, in clay.
Girvan Harbour, section in brownish-red clay; Dipple tilework.
Glasgow, Baillieston; Govan; Jordanhill; Stobcross.
Govan, near Glasgow, at Fairfield, in sand and clay.
Greenock, Cartsdyke, in laminated clay; Garvel Park, Dock section.
Gourock.

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[1] **Mostly at or near Sea-level.**

Helensburgh, Ardencaple, near.
Irvine, Bogside ; Kennox ; Shewalton.
Jordanhill, near Glasgow, in clay.
Kames Bay, Bute, shore section.
Kennox, near Irvine, river section in sandy mud.
Kilchattan Tilework, Bute, section in sandy mud.
Kilmaurs, Woodhill Quarry near.
Kilwinning, Town of, in sandy mud.
Kyles of Bute, Ettrick Bay.
Loch Fyne, near Strachur, in clay ; Ardmarnock.
Lucknow, near Stevenston, in pit sinking.
Misk, near Stevenston, in pit-sinking, in sand and sandy mud, or laminated clay.
Monkton, Adamton near.
Old Mains, Renfrew, in sand and "earth."
Neilston, Cowdenglen near.
Paisley Tileworks, in opencast pits ; Arkleston railway cutting.
Paisley Canal, in grey clay.
Raes Gill, near Carluke.
Renfrew, Old Mains near.
Rothesay, Island of Bute.
Shewalton, near Irvine, river section, in sand and sandy mud.
Stobcross Dock, Glasgow, in laminated clay.
Stevenston, Lucknow ; Misk, in blue clay.
Strachur, Loch Fyne, in clay.
Tangy Glen, near Campbeltown.
Tarbert, East, in clay.
Troon Gaswork, excavations in sandy clay and sand.
Woodhill Quarry near Kilmaurs.

THE ROCKS OF THE CLYDE DRAINAGE AREA.

BY JOSEPH SOMMERVILLE AND G. R. THOMPSON.

THE Rocks of the district are given in a tabulated form, and are chiefly compiled from Sir Archd. Geikie's "Ancient Volcanoes of Britain," the *Memoirs of the Geological Survey of Scotland*, and the *Transactions of the Geological Society of Glasgow.*

IGNEOUS ROCKS.

The Igneous Rocks have been classified from their chemical and mineralogical composition. For their positions in geological chronology, see "The Ancient Volcanoes of Britain." They are divided into four groups as follows:—

Acid group.—Those containing over 65 per cent. of silica.
  Granite—Arran: Loch Doon: Spango.
  Micro-Granite, Eurite or Granulite—Ailsa Craig.
  Graphic Granite or Pegmatite—Cowal District.
  Felsite—Quartz-porphyry and Feldspar-porphyry or Porphyrite—Tinto: Lochfyne: Ballantrae.
  Pitchstone—Arran.
Intermediate group.—Those containing 55 to 65 per cent. of silica.
  Lamprophyre, including Kersantite, Camptonite, Vogesite, etc.—Cowal District.
  Diorite—Girvan and Cowal districts.
  Trachyte—in dykes in the Cowal district.
  Andesite—largely represented in the district and often amygdaloidal. Dumbarton, Ayr, Renfrew, and Lanark shires.
Basic group.—Those containing 45 to 55 per cent. of silica.
  Gabbro: Hornblend gabbro and Hyperite—Girvan: Cowal.
  Basalt—common in the district in intrusive sheets and dykes, often columnar.
  Tachylyte—a basalt glass forming selvages of basalt dykes—Whiteinch: Lendalfoot. Mr. Clough has found it in the centre as well as on the selvages of dykes; see *Survey Memoir:* "The Geology of Cowal."
  Dolerite—common all over the district in dykes and intrusive sheets. Where it has been erupted or intruded amongst carbonaceous strata its usual dark colour has been changed into grey and white.
  Diabase and Diabase porphyrite, showing pillow structure—Girvan district: Dumgoyn.
Ultra-Basic group.—Those containing generally less than 45 per cent. of silica.
  Serpentine—Lendalfoot: Innellan.
  In this group may also be noted Olivine-enstatite rock and Hornblend-picrite—Girvan district.

VOLCANIC FRAGMENTAL ROCKS.

Volcanic agglomerate—Dumbuck: Campsie Hills: Renfrewshire and Ayrshire.

Volcanic Conglomerate and Breccia—Ayrshire.

„ Tuff—This is found associated with the agglomerate. A very fine variety known as Water-of-Ayr-stone was recently exposed in a fine section at Troon.

METAMORPHIC ROCKS.

A group of these rocks are well exposed in Argyllshire, passing into Bute and forming a rim around the granite area in Arran. These are more fully described by Mr. Peter Macnair, p. 414. Their geological age has not yet been ascertained, but probably they are not younger than Silurian.

They consist of altered igneous rocks, forming Epidiorites, Hornblende, and Chlorite-schists and Serpentines.

The rocks of sedimentary origin are altered to Gneissose-grits, Schistose-grits, Schistose-greywackes, Albite-schists, Graphite-schists, Mica-schists, Schistose-limestones, Phyllites, and Chlorite-epidote-schists. See the Green beds of the Geology of Cowal.

AQUEOUS OR SEDIMENTARY ROCKS.

(The Aqueous or Sedimentary Rocks are given in ascending geological order.)

Silurian.

Sandstones, Greywackes, Grits, Breccias, Conglomerates (Haggis rock), Mudstones, Radiolarian Cherts, Limestones, etc.—Ayrshire and Lanarkshire.

Old Red Sandstone.

Red Sandstones, Breccias and Conglomerates, Cornstones and Magnesian-limestones—Ayr, Lanark, Dumbarton, and Argyle shires.

Carboniferous Rocks.

The rocks of this formation are largely developed in the counties of Lanark and Ayr, and consist of thick-bedded Limestones and Sandstones, Grits, Conglomerates, Shales, Fireclays, Blackband Ironstones, and numerous seams of Coal.

Permian (?) or New Red Sandstone.

Red Sandstones—Ayrshire.

Pleistocene or Glacial Beds.

Boulder-clay, Stratified clays, Sands and Gravels, Moraines, and Kames, Erratic blocks, etc.

These rocks are abundant all over the district. See "The Great Ice Age," by Prof. James Geikie; "The Drift or Glacial Deposits of Ayrshire," by Mr. John Smith; and the *Transactions of the Geological Society of Glasgow.*

Recent Beds.

Alluvium in the river valleys.

Blown sand—along the shore from Ardrossan to Ayr: near Ardlamont Point, Argyllshire.

Raised-Beaches—along the shores of the river and firth of Clyde.

Peat—extensive tracts occur on many parts of the district, chiefly in Lanark and Ayr shires, as at Shotts, Aird's Moss, etc.

Soil—Boulder-clay deposits being extensive in the district, a great part of the soil is the weathered surface of that clay. There is also fine soil produced by the disintegration of some of the volcanic rocks.

Talus—This is found at the base of cliffs and steep slopes.

THE MINERALS OF THE CLYDE DRAINAGE AREA.

BY JOSEPH SOMMERVILLE AND G. R. THOMPSON.

THIS list of minerals has been compiled from various sources, amongst which may be mentioned *The Mineralogical Magazine*; *The Transactions of the Royal Society of Edinburgh*; The "Memoirs of the Geological Survey of Scotland"; *The Transactions of the Edinburgh Geological Society*; and *The Transactions of the Geological Society of Glasgow*. The classification with the chemical formulae are based upon Dana's "System of Mineralogy," 1892. A few of the more important local varieties are given, but synonyms have been avoided as far as possible. A number of the better known ones are, however, given in the alphabetical index with a reference number to the species to which they belong.

NATIVE ELEMENTS.

1.	Diamond ? C	Craigman.
2.	Graphite, C	Craigman : Shotts : Hurlford.
3.	Gold, Au	Leadhills : Wanlockhead : Ailsa Craig : M'Phun's Cairn.
4.	Silver, Ag	Campsie Hills : Corrie Glen : Enterkin : M'Phun's Cairn.
5.	Copper, Cu	Barrhead : Mauchline : Corrie Glen.
6.	Iron (Meteoric) Fe	Fell at Possil, near Glasgow, 5th April, 1804.

SULPHIDES.

7.	Stibnite, Sb_2S_3	Hare Hill : New Cumnock.
8.	Galena or Galenite, PbS	Leadhills : Corrie Glen : Dockra.
9.	Chalcocite, Cu_2S	Ayrshire.
10.	Sphalerite or Blende, ZnS	Wanlockhead : Strontian.
11.	Pentlandite, $(Fe. Ni)S$	Inveraray.
12.	Greenockite, CdS	Bishopton : Barrhead : Kilpatrick Hills.
13.	Millerite, NiS	Dockra : Broadstone.
14.	Niccolite, $NiAs$	Inveraray : Wanlockhead : Leadhills.
15.	Pyrrhotite, $Fe_{11}S_{12}$	Loch Long : Appin.
16.	Inverarite of Heddle. Sulphide of Iron and Nickel.*	Near Inveraray.
17.	Chalcopyrite, $CuS. Co_2S_3$	Wanlockhead.
18.	Pyrite, FeS_2	Common in volcanic and derivative rocks. Dunoon : Leadhills.
19.	Smaltite, $CoAs_2$	Inveraray.
20.	Marcasite, FeS_2	Lanarkshire and Ayrshire coal-fields, common.
21.	Kermesite, Sb_2S_2O	Hare Hill : New Cumnock.

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* Same as Pyrrhotite.

CHLORIDES AND FLUORIDES.

22. Halite (common salt), NaCl Only obtained in the district by the evaporation of sea-water.
23. Fluorite, CaF_2 Gourock : Broadstone : Wanlockhead : in clear crystals at Waterland, Lugton.

OXIDES.

24. Quartz (Rock Crystal), SiO_2 In fine crystals at Leadhills : Campsie Hills : Gourock : Cathkin : and other localities. In minute double-terminated crystals in sooty coal at Kilwinning, and in microscopic crystals from Carbonite (columnar coal) from Paisley, Provanhall, and other places where a coal-seam has been altered by intrusive Dolerite.

    The following varieties and localities may also be noted : Amethystine—Carrickshore : Leadhills : Langbank : Galston : Dalry Hills : Cathcart Castle. Milky—Galston. Ferruginous—Bute : Stockie Muir. Calcedony — Galston. Cornelian — Cantyre. Agate — Galston. Agate-Jasper—Dunglass : Galston. Plasma—Kilwinning. Jasper—Burn Ann : Galston : Spout of Ballagan : Lendalfoot : Dunglass. Flint—Beith : Dunoon. Heliotrope—Cantyre. Smoky—Arran. Quartzyte—Campsie : Black Craig : Argyllshire.
25. Opal, SiO_2 with water Corrie Glen.
26. Valentinite, Sb_2O_3 New Cumnock.
27. Cervantite, Sb_2O_4 Hare Hill.
28. Water, H_2O In abundance in the liquid form everywhere in the district and in the crystalline form as Snow and Ice in winter.
29. Cuprite, Cu_2O Wanlockhead.
30. Tenorite or Melaconite, CuO Leadhills.
31. Haematite, Fe_2O_3 Leadhills : Loch Doon : Kilbirnie Hills.
32. Reddle, Fe_2O_3 a variety of Haematite Dalry.
33. Ilmenite or Menaccanite, $FeTiO_3$ Holy Loch : Glen Massan : Bute : Cantyre : Loch Long.
34. Picotite—Chrome Spinel, $(Mg.Fe)O(AlCr)_2O_3$ as a constituent of some volcanic rocks.
35. Magnetite, $FeO.Fe_2O_3$ Bute : Loch Long : Logan Water.
36. Minium, Pb_3O_4 Leadhills.
37. Rutile, TiO_2 Cowal district.
38. Plattnerite, PbO_2 Leadhills : Wanlockhead.
39. Octahedrite, TiO_2 Earn, W. of Loch Lomond.
40. Pyrolusite, MnO_2 From dredgings in Loch Fyne : Leadhills.
41. Göthite, $Fe_2O_3H_2O$ Kilpatrick Hills : Gourock.
42. Limonite, $2Fe_2O_33H_2O$ Lochfine : Mull of Cantyre.
43. Psilomelane, H_4MnO_5 Kilpatrick Hills : Leadhills.
44. Wad—Bog-Manganese. Composition variable but chiefly an oxide of Manganese. Gourock : Renton : Cathkin : Bowling : Leadhills : Burrmill.
45. Asbolite. A variety of Wad containing Oxide of Cobalt. Tyndrum.

OXYGEN-SALTS—CARBONATES.

46. Calcite, CaO_3 In many crystalline forms ; the ordinary rhombic ; Dog-tooth and Nail-head, at Dockra : Gourock : Campsie Hills : Dalry : Waterland : Leadhills : Barrhead : and as Limestone at Beith : Campsie Hills : Nitshill : as Rock-Milk at Cleaves Cove, Dalry : Pink crystals occur at Gourock.

47. Dolomite, $(CaMg)CO_3$ Gourock : Wanlockhead : Toward : Cantyre.
48. Magnesite, $MgCO_3$ Inch Moran, Loch Lomond.
49. Siderite, $FeCO_3$ Lanarkshire and Ayrshire coal-fields as black-band, clayband and musselband ironstone, a variety having a cone-in-cone structure at Temple : Possil : Rutherglen : Stewarton : Lugton.
50. Smithsonite (Calamine), $ZnCO_3$ Leadhills : Wanlockhead.
51. Aragonite, $CaCO_3$ Dockra : Auchenharvie : Shettleston : Campsie : Greenock Hills : Dalry : Stevenson.
52. Bromlite, $(BaCa)CO_3$ Leadhills : Wanlockhead.
53. Witherite, $BaCO_3$ Leadhills : Wanlockhead.
54. Strontianite, $Sr. CO_3$ Strontian.
55. Cerusite, $PbCO_3$ Leadhills : Wanlockhead.
56. Barytocalcite, $BaCO_3CaCO_3$ Leadhills : Wanlockhead.
57. Malachite, $2CuO. CO_2. H_2O$ Leadhills : Barrhead : Cowal : Aberfoyle.
58. Azurite or Chessylite, $3CuO. 2CO_2H_2O$ Leadhills : Wanlockhead.

OXYGEN-SALTS—SILICATES.

59. Orthoclase-Potash Feldspar, $KAlSi_3O_8$ Arran : Bute : Kilpatrick : Cowal : Corriegills, Arran.
60. Erythrite, a flesh-red variety of Orthoclase. Kilpatrick Hills.
61. Weissegite, a variety of Orthoclase. Campsie Hills : Kilpatrick : Hartfield Moss.
62. Murchisonite, a variety of Orthoclase. Arran.

62A. *Plagioclase Series.* Albite to Anorthite.

63. Albite, $NaAlSi_3O_8$ Cowal district.
64. Oligoclase ? Cowal district.
65. Labradörite, Ballantrae : and in the basaltic dykes of the district.
66. Bytownite ? In the basalt dykes of Cowal.
67. Anorthite, $CaAl_2Si_2O_8$ Lendalfoot in dolerite.
68. Christianite and Latrobite are the same as Anorthite.
69. Enstatite, $MgSiO_3$ Lendalfoot.
70. Bronzite, $MgSiO_3$ with Iron Lendalfoot.
71. Bastite or Schiller-Spar, an altered Enstatite or Bronzite. Balhamie Hill.
72. Hypersthene ? $(FeMg)SiO_3$ Strachur : Inveraray.

72A. *Pyroxene Group.* Composition various.

73. Augite, $CaMgSi_2O_6$ with alumina Arran : Fairlie : Cowal.
74. Diallage, Lendalfoot.
75. Pectolite, $HNaCo_2(Si_2O_3)_3$. Kilsyth : Girvan : Lendalfoot : Knockdolian Hill.

75A. *Amphibole Group.*

76. Anthophyllite, $(MgFe)SiO_3$ Girvan.
77. Asbestos, comp. various Lochfineside : Girvan.
78. Hornblende, comp. various Dunoon.
79. Tremolite, $CaMg_3Si_4O_{12}$ Inveraray.
80. Actinolite ? $Ca(MgFe)_3Si_4O_{12}$ Cowal district.
81. Mountain Leather, Leadhills : Strontian.
82. Uralite, Dunoon.
83. Riebeckite, $2NaFe(SiO_3)_2FeSiO_3$ Ailsa Craig.
84. Iolite or Cordierite, $H_2(MgFe)_4Al_8Si_{10}O_{37}$ Glenfine : Cowal.
85. Garnet, composition various Glenbucket : Strontian.
86. Crysolite, $(MgFe)_2SiO_4$ Kilpatrick and Renfrewshire Hills : Cowal district.
87. Ferrite, an altered Chrysolite Gleniffer : Boylstone : Cowal district.
88. Willemite, Zn_2SiO_4 Wanlockhead.

89. Vesuvianite or Idocrase, a basic calcium-aluminium silicate. Cowal district.
90. Zircon, $ZrSiO_4$ Strontian.
91. Sillimanite or Fibrolite, Al_2SiO_5 Glen Fyne : Cowal.
92. Datholite or Datolite, $HCaBSiO_5$ Kilpatrick : Bishopton : Barrhead.
93. Zoisite ? $HCa_2Al_3Si_3O_{13}$ Cowal district.
94. Epidote, $HCa_2(AlFe)_3Si_3O_{13}$ Bute : Arran.
95. Prehnite, $H_2Ca_2Al_2Si_3O_{12}$ Bowling : Barrhead : Bishopton.
96. Calamine, HZn_2SiO_5 Leadhills.
97. Tourmaline, a complex silicate of boron and aluminium. Cowal district.
98. Okenite, $2H_2OCaO2SiO_2$ Carleton Castle.
99. Apophyllite, $K_2O. 8CaO. 16Si_2O. 16H_2O$ Kilpatrick Hills : Strontian.

99A. *Zeolites.*

100. Heulandite, $H_4CaAl_2Si_6O_{18}+3H_2O$ Kilpatrick Hills : Little Cumbrae.
101. Brewsterite, $H_4(SrBaCa)Al_2Si_6O_{18}+3H_2O$ Strontian.
102. Harmotome, $H_2(K_2Ba)Al_2Si_5O_{15}+4H_2O$ Strontian : Campsie Hills : Kilpatrick Hills.
103. Stilbite, $H_4(Na_2Ca)Al_2Si_6O_{18}+4H_2O$ Cochno : Campsie Hills : Arran : Little Cumbrae.
104. Laumontite, $H_4CaAl_2Si_4O_{14}+2H_2O$ Kilpatrick, Campsie Hills : Renfrewshire Hills.
105. Chabazite, $(CaNa_2)Al_2Si_4+6H_2O$ Kilpatrick Hills : Kilmalcolm : Dalry.
106. Levynite, $CuAl_2Si_3O_{10}+5H_2O$ Hartfield Moss.
107. Analcite, $NaAlSi_2O_6+H_2O$ Barrhead : Port-Glasgow : Inverkip : Kilpatrick Hills : Strontian.
108. Cluthalite, var. of Analcite with flesh-red crystals. Bowling : Little Cumbrae : Fergushill Ha', Kilwinning.
109. Edingtonite, $BaAl_2Si_3O_{10}+3H_2O$ Kilpatrick Hills.
110. Glottalite, var. of Edingtonite Port-Glasgow.
111. Natrolite, $Na_2Al_2Si_3O_{10}+2H_2O$. Kilmalcolm : Port-Glasgow : Campsie Hills : Kilpatrick Hills : Cowal : Cloch.
112. Galacite, var. of Natrolite Berry Glen, Ayrshire.
113. Scolecite, $CaAl_2Si_3O_{10}+3H_2O$ Kilpatrick Hills.
114. Mesolite, Composition between Natrolite and Scolecite. Kilpatrick Hills : Hartfield Moss.
115. Thomsonite $(Na_2Ca)Al_2Si_2O_8+H_2O$ Bowling : Kilmalcolm : Port-Glasgow.
116. Dolianite, a doubtful Zeolite Knock Station, Ayrshire.

116A. *Mica Division.*

117. Muscovite, $H_2KAl_3(S_2O_4)_3$ In granites and sandstones.
118. Sericite, a variety of Muscovite In schists of the Cowal district.
119. Agalmatolite ? an amorphous mineral with a composition near muscovite Cowal district.
120. Paragonite, sodium mica Cowal district.
121. Lepidolite, Lithium Mica Argyleshire.
122. Biotite, Magnesium-iron Mica Dalry : Cowal.
123. Haughtonite (Heddle), same as Biotite.
124. Clinochlore, $H_8(MgFe)_5Al_2Si_3O_{18}$ Inveraray.
125. Prochlorite or Chlorite, $H_{40}(FeMg)_{23}Al_{14}Si_{13}O_{90}$ Cowal district.
126. Delessite, $H_{10}(MgFe)_4(AlFe)_4Si_4O_{22}$ Bowling : Dumbuck : Long Craigs.
127. Chlorophaeite of Macculloch, a chloritic mineral. Loch Fyne : Strachur.

127A. *Serpentine and Talc Division.*

128. Serpentine, $H_4Mg_3Si_2O_9$ Lendalfoot : Colmonell : Innellan.
129. Antigorite, a variety of Serpentine Toward.
130. Chrysotile, a fibrous variety of Serpentine Lendalfoot : Games Loup.
131. Talc or Steatite, $H_2Mg_3Si_4O_{12}$ Toward : Bute.

132. Saponite, a hydrous silicate of magnesium and aluminium, composition variable. The three following are local varieties.
133. Bowlingite Bowling: Auchenharvie.
134. Cathkinite Cathkin.
135. Prasilite Kilpatrick Hills.
136. Celadonite, a silicate of iron, magnesium and potassium Galston.
137. Glauconite, a hydrous silicate of iron and potassium Old Kilpatrick: Little Cumbrae.
138. Kaolinite? composition not determined. Troon.
139. Chrysocolla, $CuSiO_3+2H_2O$ Leadhills.
140 Chonicrite, a hydrous silicate. Colmonell: Lendalfoot: Dalry.
141. Pilolite, „ „ Leadhills.
142. Titanite, $CaTiSiO_5$ River Fyne near Newton Hill: Strontian.

Oxygen Salts—Phosphates, Etc.

143. Apatite, $(CaF)Ca_4(PO_4)_3$ or $(CaCl)Ca_4(PO_4)_3$ In igneous rocks and schists of the Cowal district.
144. Coprolites, amorphous phosphates In shales of the carboniferous system of the district.
145. Pyromorphite, $(PbCl)Pb_4P_3O_{12}$ Leadhills.
146. Mimetite, $(PbCl)Pb_4As_2O_{12}$ Leadhills: Wanlockhead.
147. Vanadinite, $(PbCl)Pb_4V_3O_{12}$ Wanlockhead.
148. Olivenite, $Cu_2(OH)AsO_4$ Leadhills: Wanlockhead.
149. Dechenite, PbV_2O_6 Leadhills.
150. Erinite, $Cu_5(OH)_4P_2O_8$ Leadhills.
151. Vivianite, $Fe_3P_2O_8+8H_2O$ Leadhills.
152. Annabergite, $NiAs_2O_8+8H_2O$ Wanlockhead.
153. Uraninite, a uranate of uranyl, Lead formula uncertain. Wanlockhead.

Oxygen Salts—Sulphates, Chromates, Etc.

154. Barite, $BaSO_4$ Aberfoyle: Gourock: Leadhills: Corrieburn: Queenside Hill: Arran.
155. Calcareobarite, a variety of Barite containing Lime. Strontian.
156. Celestite, $SrSO_4$ Auchenreoch Glen.
157. Anglesite, $PbSO_4$ Leadhills: Wanlockhead.
158. Vauquelinite, a phospho-chromate of Lead Leadhills: Wanlockhead.
159. Leadhillite, $4PbOSO_32CO_2H_2O$ Leadhills.
160. Susannite, a sulphate-tricarbonate of Lead Leadhills.
161. Lanarkite, Pb_2SO_5 Leadhills.
162. Caledonite, $(PbCu)SO_4(PbCu)OH_2$ Leadhills.
163. Linarite, $(PbCu)SO_4(PbCu)OH_2$ Leadhills.
164. Mirabilite, $Na_2SO_4+2H_2O$ Hurlet.
165. Gypsum, $CaSO_4+2H_2O$ Spout of Ballagan: Hamilton: Ayr: Auchenreoch Glen.
166. Epsomite? $MgSO_4+7H_2O$ Giffnock.
167. Melanterite, $FeSO_4+7H_2O$ Hurlet: Kilpatrick.
168. Chalcanthite, $CuSO_4+5H_2O$ Wanlockhead.
169. Kalinite, $K_2SO_4. Al_2(SO_4)_3+24H_2O$ Campsie: Hurlet.
170. Halotrichite, $FeSO_4Al_2(SO_4)_3+24H_2O$ Giffnock: Auchenskeith: Hurlet: Campsie.

Hydrocarbon Compounds.

171. Albertite Nitshill.
172. Urpethite Dalry.
173. Anthracite Rankinston: Hurlford: Provanhall.
174. Middletonite Stevenston: Hurlford: Kilmarnock.

175. Ozokerite	Dalry : Airdrie.
176. Carbonite, native coke	Paisley : Provanhall : Kilwinning.
177. Elaterite	Dalry : Airdrie.
178. Hatchittite, Mountain tallow.	Lochfyne.
179. Chrismatite	Lugar in blackband ironstone.
180. Asphaltum	Hurlet : Bishopbriggs.
181. Mineral Charcoal	Between layers of nearly all coals.

Mornite ; see Labradorite, 65.
Morvenite ; see Harmotome, 102.
Mountain Leather, 81.
Murchisonite, 62.
Muscovite, 117.
Musselband Ironstone ; see Siderite, 49.

N.
Natrolite, 111.
Needle Spar ; see Aragonite, 51.
Niccolite, 14.

O.
Octahedrite, 39.
Okenite, 98.
Oligoclase, 64.
Olivenite, 148.
Olivine ; see Chrysolite, 86.
Opal, 25.
Orthochase, 59.
Ozokerite or Ozocerite, 175.

P.
Paragonite, 120.
Pectolite, 75.
Pentlandite, 11.
Peridot ; see Chrysolite, 86.
Picotite, 34.
Pilolite, 141.
Pitchblend ; see Uraninite, 153.
Pitchstone ; see Felspar, 59.
Plagioclase Series, 62A.
Plasma ; see Quartz, 24.
Plattnerite, 38.
Plumbocalcite ; see Calcite, 46.
Poonahlite ; see Scolecite, 113.
Potash Feldspar ; see Orthoclase, 59.
Prasilite, 135.
Prehnite, 95.
Prochlorite, 125.
Psilomelane, 43.
Pyrite, 18.
Pyrolusite, 40.
Pyromorphite, 145.
Pyroxene Group, 72A.
Pyrrhosiderite ; see Göthite, 41.
Pyrrhotite, 15.

Q.
Quartz, 24.

R.
Ratholite ; see Pectolite, 75.
Reddle, 32.
Riebeckite, 83.
Ripidolite ; see Clinochlore, 124.
Rock Crystal ; see Quartz, 24.
Rock Milk ; see Calcite, 46.
Rutile, 37.

S.
Sagenite ; see Rutile, 37.
Saponite, 132.
Satin Spar ; see Aragonite, 51.
Schiller Spar ; see Bastite, 71.
Schorl ; see Tourmaline, 97.
Scolecite, 113.
Sericite, 118.
Serpentine and Talc Division, 127A.
Serpentine, 128.
Siderite, 49.
Sillimanite, 91.
Silver, 4.
Smaltite, 19.
Smithsonite, 50.
Smoky Quartz ; see Quartz, 24.
Specular Iron ; see Haematite, 31.
Sphalerite, 10.
Sphene ; see Titanite, 142.
Steatite ; see Talc, 131.
Stibnite, 7.
Stilbite, 103.
Strontianite, 54.
Susannite, 160.

T.
Talc, 131.
Tenorite, 30.
Thomsonite, 115.
Titanite, 142.
Tourmaline, 97.
Tremolite, 79.
Troostite ; see Willemite, 88.

U.
Uralite, 82.
Uraninite, 153.
Urpethite, 172.

V.
Valentinite, 26.
Vanadinite, 147.
Vauquelinite, 158.
Vesuvianite, 89.
Vivianite, 151.

W.
Wad, 44.
Water, 28.
Weissegite, 61.
Willemite, 88.
Witherite, 53.

Z.
Zeolites, 99A.
Zircon, 90.
Zoisite, 93.

LOCALITIES FOR OLD RED SANDSTONE AND CARBONIFEROUS FOSSILS IN THE CLYDE DRAINAGE AREA.

By John Smith.

The following list of localities in the Clyde area where Carboniferous and Old Red Sandstone fossils have been or may be obtained, has been drawn up for the use of geological observers. The distances given are those from the nearest railway stations. The formations and their various divisions are indicated by letters as follows :

(C.) = Carboniferous.
(O.R.S.) = Old Red Sandstone.
(P.) = Permian.
U.C.S. = Upper Coal Series (Scotland).
U.I.S. = Upper Ironstone Series.
U.L.S. = Upper Limestone Series.
L.C.S. = Lower Coal Series.
L.I.S. = Lower Ironstone Series.
L.L.S. = Lower Limestone Series.
C.S. = Calciferous Sandstone Series.

Airdrie (C.) ; pits in U.C.S. ; *Cypridina*, fish, plants, etc.
Alton Burn, 1½ m. N. of Galston (C.) ; *Serpulites*, etc.
Annbank, pits near (C.) ; *Lingula*, *Carbonicola*, etc., in U.C.S.
Annicklodge, 1½ m. E.S.E. of Montgreenan (C.) ; in oil-shale in U.C.S. ; *Anthracosaurus*, and fish-remains.
Annick Water, 2 m. N.E. of Stewarton (C.) ; L.L.S.
Arden, near Thornliebank (C.) ; U.L.S. ; cement-limestone workings ; *Estheria*, *Athyris* with spiral arms, etc.
Ardrossan, S. shore-section (C.) ; L.I.S.
Arran, near the Cock (P.) ; derivative fossils in conglomerate.
„ Cock ; on shore (C.) ; *Mariopteris*, etc.
„ Corrie (C.) ; shore-section with marine fossils.
„ „ (C.) ; quarry ; *P. giganteus*, etc., in L.L.S.
„ Fallen Rocks ; *Calamites*.
„ Glen Shurig (O.R.S.) ; *Psilophyton*.
„ Maol Donn, N. side (C.) ; *Calamites*, etc.
„ Merkland Burn, 1¾ m. N. of Brodick (C.) ; *Carbonicola*, etc.
„ Millstone Point ; *Calamites*.
„ Salt Pans (C.) ; shore-sections, fossils common in U.L.S.
„ Salt Pans, N.E. shore (C.) ; fine *Anthracite* coal-field extending under the sea in L.C.S.
„ Sliddery Water-head (C.) ; *Carbonicola*, *Lepidostrobus*, *Megalichthys*, etc.
Arthurlie, ½ m. S. of Barrhead (C.) ; burn section.

Auchenbeg, near Coalburn (C.); U.L.S.; *Dithyrocaris*, *Leda*, *Mytilus*, *Solenopsis*, etc.
Auchencloich, 2½ m. W. of Kilbirnie (C.); L.L.S.
Auchengree, ½ m. S.E. of Kilbirnie, G. & S.-W. Ry. (C.); L.I.S.; *Sphenopteris*, etc.
Auchenharvie, W. of Stevenston, pits (C.); U.C.S.; *Prestwichia*, *Carbonicola*, etc.
Auchenreoch Glen, N.E. of Dumbarton (C.); C. S.; Ballagan limestone group.
Auchenskeith, 2½ m. S.E. of Dalry (C.); L.L.S.; *Cladochonus*, *Fistulopora*, *Polyrhizodus*, etc.
Auchentorlie Glen, Bowling (C.); plants with structure in C.S.
Auchenmade, near the Station (C.); L.L.S.
Auchenheath (C.) old shale heaps of "Lesmahagow" gas-coals, L.I.S.
Auchinleck, pits near (C.); U.C.S.
Auchmeden, 2½ m. E. of Lesmahagow (C.); L.L.S.
Auchreen, 1½ m. E. of Lesmahagow (C.); L.L.S.
Auchter Water, 3 m. E. of Wishaw (C.); curly ironstone shale-heaps.
Auldhouseburn, ¾ m. E. of Muirkirk (C.); L.L.S.
Avon Water, near Hamilton (C.); *Sphenopteris*, etc., in U.C.S.
Ayr Water, 1½ m. S. of Tarbolton (C.); U.C.S.; hone (snakestone) mine and quarry, occasional ferns in the honestone.
Baillieston (C.); *Palaeophalangium*, *Psilotites*, *Pecopteris*, etc., in U.C.S.
Baldernock Linn, near Lennoxtown (C.); estuarine or freshwater limestone in L.L.S.
Balglass Burn, near Lennoxtown (C.); L.L.S.
Balgrochan Burn, near Lennoxtown (C.); L.L.S.
Ballagan Burn, near Strathblane (C.); C.S.; Ballagan limestone group.
Ballochmyle, 2 m. E. of Mauchline (C.); *Spirorbis* limestone on N. bank of Ayr Water in U.C.S.
Bank, 2 m. S.E. of New Cumnock (C.); U.C.S.
Banton, near Kilsyth (C.) U.L.S.; and L.I.S.; *Lepidodendron*, fish-remains, etc.
Bargeddie near Shettleston (C.); U.C.S.; *Anthracoptera*, etc.
Barkip, 3 m. E. of Dalry (C.); pits in L.C. and I.S.
Barmulloch, 2½ m. W. of Steps Road (C.); U.L.S.; *Loxonema*, Polyzoa, etc.
Bashaw, 2 m. N.E. of Carluke (C.); U.L.S.; shale-heaps from the Gare and Main limestones.
Beith (C.); L.L.S.; *Ulodendron*, *Psammodus*, *Cyathophyllum*, etc.
Bello Water, 1 m. E. of Lugar (C.); *Carbonicola*, etc., in U.C.S.
Bellshill (C.); pits in U.C.S.
Belston Place Burn, 1¼ to 1½ m. N. of Carluke (C.); U.L.S.
Benhar, 2 m. N. of Fauldhouse (C.); crustaceans, etc.; in slatyband ironstone.
Benston, between Old and New Cumnock (C.); U L.S.; corals, etc.
Birkhead, on Caaf Water, 2¾ m. E. of Dalry (C.); conodonts, sponge-spicules, etc., in L.L.S.
Birkwood Burn, 1½ m. N. by W. of Lesmahagow (C.); L.L.S.
Birkwood Quarry, 2 m. N. of Lesmahagow (C.); L.L.S.
Bishopbent, 2¾ m. S.E. of Carluke (C.); opencast working of Raes Gill ironstone in L.L.S.
Bishopbriggs (C.); shale-heaps and railway sections in L.C. and I.S.
Blackcraig, 1¾ m. E. of E. Kilbride (C.); *Lingula* shales.
Blackhall, 1 m. S.E. of Paisley (C.); marine and freshwater ostracoda limestones in L.L.S.
Blackstone, 2 m. N.W. of Paisley (C.); pits in L.I. and L.S.
Blackstone, 2½ m. west of Dalry (C.); L.L.S.
Blantyre (C.); pits in U.C.S.
Boghead, 3 m. N.W. of Lesmahagow (C.); corals, etc., in L.L.S.; *Lonsdaleia*, etc.

Boghead Burn, 2½ m. N.E. of Cronberry (C.); limestone, etc.
Boghead, 2 m. W. of Quarter Road (C.); Calderwood limestone; once a good locality.
Bombo Burn, at waterfall, 1 m. E. of Dalry (C.); rich fossiliferous shale in U.L.S.; *Serpulites*, etc.
Bourrock, 1¼ m. N. of Dunlop railway section (C.); outlier of L.L.S.
Bowertrapping, 3 m. N.E. of Dalry (C.); trilobites, etc.; a good locality in U.L.S.; *Streptorhynchus*, *Strophomena*, *Naticopsis*, etc.
Braehead, ½ mile N. of Eaglesham Road (C.); labyrinthodont-remains in a quarry in L.L.S.
Braidwood (C.); main linestone; *Saccammina*, *Textularia*, etc.
Braidwood Gill, 2 m. S. of Carluke (C.); U.L.S. and L.L.S.
Brankumhall, 1 m. N.E. of E. Kilbride (C.); Ure's locality of "Laurieston."
Broadlie, 1½ m. N.W. of Dalry (C.); U.L.S.; *Kirkbya*, *Dentalium*, etc., on side of old railway.
Brockley, 1¾ m. N.W. of Douglas (C.); banks of Ponniel Water, a good locality; ostracoda and foraminifera abundant in shale in L.L.S.
Brock's Hole, 1 m. E. of Carluke (C.); U.L.S.
Broadlie Glen, 1½ m. N.W. of Dalry (C.); U.L.S.; rich fossiliferous shale.
Browntod, 1 m. S.W. of Quarter Road (C.); U.L.S.; *Acrolepis*, *Pleurotomaria*, etc.
Bullerholes, 4 m. N.E. of Kilwinning (C.); U.L.S.; fine section of Index limestone.
Burn Ann, 1 m. S.E. of Galston (C.); U.C. and L.S.; *Posidonomya*, *Pteronites*, etc., 1¾ m. S. of Newmills, *Carbonicola*, etc., in L.L.S.
Burnbrae, near Milton of Campsie (C.); U.L.S.
Burntongues Burn, 2 m. N.W. of Dalry (C.); *Lingula* shale, ironstone, and limestone in L.I. and L.S.
Byrehill, 1¼ m. S. of Stewarton (C.); L.L.S.
Caaf Water, above Giffartland (C.); U.L.S.; volcanic debris with derivative fossils.
Caaf Water, ¾ m. S.W. of Dalry (C.); middle beds of U.L.S., with a bed of *Productus latissimus*, *Beyrichia*, etc.
Caaf Water, 150 yards above Giffartland Mill, 2¾ m. S.W. of Dalry (C.); shale with fish-remains above shale and limestone.
Caaf Water, at Drumcastle Mill, and Holms of Caaf, 1¾ m. S.W. and W.S.W. of Dalry (C.); U.L.S.
Caaf Water at Giffartland, 2 m. W.S.W. of Dalry (C.); U.L.S.; limestone and shale.
Cairn Table Hill, N.W. foot of (C.); old quarries in L.L.S.
Calderbank, 2 m. S. of Airdrie (C.); *Aviculopecten papyraceous*, *Orthoceras*, etc.; between Kiltongue and Virtuewell coals in U.C.S.
Calderside, near High Blantyre (C.); *Janassa*, *Trigonocarpum*, etc., in cement-shales.
Calder Water, 1½ m. E. of E. Kilbride (C.); limestone and shale.
Calderwood Glen, 2 m. E.N.E. of E. Kilbride (C.); limestone and shale.
Campsie (C.); main limestone; *Camarophora*, etc.
Capelrig, 1 m. N.E. of E. Kilbride (C.); limestone and shale.
Caprington, 2 m. S.W. of Kilmarnock (C.); pits in U.C.S.
Carluke (C.); *Cyclus* in first calmy limestone; fish-remains, etc., in roof of Drumgray coal.
Carmyle (C.); shale-heaps of U.C.S.
Carnbrae (C.); shale-heaps of U.C.S.
Carrick Coast, 5 m. S. of Ayr (O.R.S.).
Cartleburn, 1½ m. N. of Kilwinning (C.); L.L.S.
Castlecary (C.) lime, and ganister pits in U.L.S., *Nautilus*, etc.
Castlehill, 1 m. N. of Carluke (C.); shale heaps of U.C.S.

Cessnock Water, 4 m. S.E. of Galston (C.); *Spirorbis* in C.S.
Chapel, 2 m. S. of Carluke (C.); "maggy" ironstone in U.L.S.
Chapel Farmhouse, 2¼ m. S. of Carluke (C.); sections on Fiddler's Burn in L.L.S.
Cleaves Glen, 2 m. S.E. of Dalry (C.); L.L.S.
Cleckhimin, 3½ m. S.E. of Carluke (C.); shale heaps of L.L.S.
Cleland (C.); pits in U.C.S.
Cleuch Burn, 4½ m. E.N.E. of Mauchline (C.); limestone, etc.
Climpy, 1½ m. W. of Wilsontown (C.); U.C.S.
Cloch, near Gourock (C.); fossiliferous shale in C.S.
Clonbeith, 3 m. N.E. of Kilwinning (C.); U.L.S.; *Bairdia*, *Platyceras*, *Nucula*, *Bellerophon*, etc.
Coalburn (C.); pits in L.C.S.
Coldgreen Glen, 3 m. S.W. of Kilbirnie (C.); limestone and shale on Paduff Burn in L.L.S.
Coltpark (C.); quarries in U.L.S.
Corbie Craigs, 1½ m. N.E. of Waterside (C.); pits, *Carbonicola* in living position in U.I.S.
Cot Castle, Stonehouse (C.); *Sphenopteris*, etc.
Corrieburn, 1½ m. N. of Twechar (C.); limestone, shale, and ironstone in L.I. and L.S.; *Cauda-galli*, etc.; a good locality.
Cowdon Burn, between Neilston and Barrhead (C.); L.L.S.
Coylton (C.); pits, and stream sections, *Carbonicola*, ferns, etc., in U.C.S.
Craigburn, 2½ m. N.N.E. of Douglas (C.); U.L.S.
Craigenglen, 1½ m. S. of Lennoxtown (C.); shale-heaps and burn-section in L.L.S.; *Archaeodiscus*, Polyzoa, Gastropods, Lamellibranchs, etc.
Craighall, 3 m. S.W. of E. Kilbride (C.); L.L.S.
Craigie, 3 m. S. of Kilmarnock (C.); L.L.S.; *Poterioceras*, Entomostraca, etc.
Craigmaddie Moor, 2½ m. N.E. of Milngavie (C.); L.L.S.
Craignethan Glen, near Tillietudlem (C.).
Crawfield, ¾ m. E.N.E. of Kilbirnie, G. & S.-W. Ry. (C.); L.L.S.
Crawfordland Burn, near Crawfordland Castle, 2½ m. N.E. of Kilmarnock (C.); U.L.S.; the only open section for *Corophioides polyupsilon*, Smith.
Crofthead, near Fauldhouse (C.); shale heaps.
Crookedstone Muir, 3 m. N. of Strathavon (C.); U.L.S.
Crossflat, near Muirkirk (C.); foraminifera abundant in L.L.S.
Crossford, 2 m. S. of Braidwood (C.); L.L.S. *Sphenopteris*, etc.
Crosshouse, 2½ m. S.W. of E. Kilbride (C.); L.L.S.
Crosshouse, near the station (C.); shale-heaps of U.C. and I.S.; *Carbonicola*, fish-remains, etc.
Croy, pits near (C.); L.I S.
Cubs Glen, 1 m. S.E. of Lugar (C.); U.L.S.; a great whin sill.
Cunningham-Baidland, 2 m. N.W. of Dalry (C.); sponge-remains abundant in the upper bed of the L.L.S.; *Conocardium*, Gastropods, etc.
Dailly, pits near the station (C.); L.C.S.
Daleagles (Daleccles), 3 m. S.W. of New Cumnock (C.); burn-section.
Dalmellington, pits and burn-sections near, (C.); U.C.S.
Dalquharran, near Dailly (C.); pits in L.C.S.
Dalry (C.); abundance of blaze bings mostly from L.I.S.; *Lepidodendron*, *Nautilus*, *Sigillaria*, *Dadoxylon*, *Anthracoptera*, etc.
Dalserf Burn, near Ayr Road (C.); U.C.S.; fish-remains, etc.
Dalzell (C.); pits in U.C.S.
Darnconnar, 1½ m. N.W. of Lugar (C.); pits in U.C. and I.S.
Darnley, 1 m. S.W. of Kennishead (C.); U.L.S.
Daviland, near Thornliebank (C.); U.L.S.
Dean, 1 m. N.N.E. of Kilmarnock (C.); sections on Crawfordland and Fenwick burns in U.C. and I.S.; *Beyrichia*, fish-remains, etc.

Den, 3 m. N. of Lesmahagow (C.); L.L.S.

Den, 2½ m. N.E. of Dalry (C.); pits in L.I.S.; *Gyracanthus*, *Rhizodus*, Entomostraca, etc.

Dennistoun, Glasgow (C.); fossiliferous shale in street cutting, *Goniatites*, etc.

Dernshaw, 3½ m. W.S.W. of Stewarton (C.); U.L.S.; *Nautilus*, *Pleurotomaria*, *Bellerophon*, etc.

Diddup, 2 m. N. of Stevenston (C.); thick bed of Arden Cement-limestone in U.L.S

Dinnans, 2 m. S.E. of Stewarton (C.); U.L.S.

Dockra, ½ m. N. of Barmill (C.); L.L.S.; *Ulocrinus*, *Psammodus*, *Poecilodus*, etc.

Douglas, pits near, in U.C.S.

Doura, 1½ m. S.E. of Montgreenan (C.); pits in U.C.S.

Draffen, near Stewarton (C.); L.L.S.

Dreghorn, pits near, (C.); *Spirorbis* ironstone, freshwater limestone, etc., in U.C.S.

Drongan (C.); pits near, U.C.S.

Drumbuie (C.); railway section ½ m. W. of Giffen in U.L.S.

Drumclog, 5 m. E. of Darvel (C.); L.L.S.

Drumpellier at Drumpark, 1½ m. W.S.W. of Coatbridge (C.); marine fossils in U.C.S.

Dubs, 1 m. S.E. of Barrhead (C.); *Goniatites*, *Cyrtoceras*, etc.

Duniflat Burn, 1 m. N.E. of Lugton (C.); L.L.S.

Duntocher, 1 m. N.E. of Dalmuir (C.); L.L.S.

Dykehead, near High Blantyre (C.); cement-shale heaps, polyzoa, crinoids, etc.

Dykes, 1½ m. N.W. of Kilbirnie, Cal. railway (C.); sponge-spicules abundant in the limestone of L.L.S.

East Burn, N.E. of Stewarton (C.); *Palaechinus*, *Aviculopecten*, etc.

East Drumloch, 3 m. S.E. of E. Kilbride (C.); L.L.S.

East Kilbride, (C.); cement-limestone, *Anthrapalaemon*, *Eoscorpius*, *Palaemysis*, *Odontopteris*, etc.

Ellismuir, near Baillieston (C.); *Cyclotheca*, *Urnatopteris*, etc., in U.C.S.

Faifley, 1½ m. N.E. of Dalmuir (C.); L.L.S.

Fergushill, S. of Montgreenan (C.); pits in U.C.S.

Ferniegair, near the Ry. Station (C.); pits in U.C.S.

Fiddler's Burn, Headsmuir, 1¼ m. E.S.E. of Carluke; Shales of L.L.S.

Gabrochill, 3 m. N.E. of Dunlop (C.); outlier of L.L.S.

Gallowhill, 1½ m. E. of Strathavon (C.); *Chiton*, bivalves, etc.

Gameshill, 1½ m. N.W. of Stewarton (C.); L.L.S.; corals, *Spirifera*, *Heterophyllia*, *Cardiomorpha*, etc.

Gare, 2 m. N.E. of Carluke (C.); a good locality in U.L.S., but heaps grassed over; foraminifera, bivalves, univalves, etc.

Garngad Road, and S. of, Glasgow (C.); U.L.S.

Garnkirk (C.); marine limestone and shale.

Garple Water, 1 m. W. of Muirkirk (C.); U.L.S. and L.L.S. in stream; sandstone with marine fossils; *Ortonia*, *Retzia*, crinoids, ostracoda, etc.

Garrion Gill, 2½ m. N.N.W. of Carluke (C.); shale heaps of Belside ironstone from U.C.S.

Garscube (C.); pits in L.I.S.

Gas Water, 2 m. E. of Cronberry (C.); L.L.S.

Gateside, Beith (C.); old quarries in L.L.S.; *Clisiophyllum*, *Columnaria*, *Michelinia*, and *Carcharopsis*.

Gateside, 2 m. E.S.E. of Carluke (C.); Raes Gill ironstone and shales in L.L.S.

Giffartland Burn, 2½ m. W.S.W. of Dalry (C.); outcrop of Dalry clayband ironstone in L.I.S.

Giffen pit, 1 m. S.W. of Giffen (C.); *Naidites* bed above a coal-seam in L.C.S.

Giffnock, 1½ m. S.W. of ry. station, (C.); section of Orchard cement-limestone on L. and A. railway.

Giffnock, Sandstone quarries near, (C.); *Knorria*, *Arenicolites*, ferns, etc.

Gill Burn, 3 m. W.S.W. of E. Kilbride (C.); Calderwood cement-limestone.

Gillfoot, 2½ m. S.S.W. of Carluke (C.); Belston Burn limestone and shale; a good locality on burn in U.L.S.; *Eoscorpius*, *Thamniscus*, *Synocladia*, etc.

Gillhead Bridge, 2¼ m. N.N.W. of Carluke (C); Kiltongue musselband in burn in U.C.S.

Girthill, 2½ m. S.W. of Dalry (C.); ostracoda abundant in shale of U.L.S.; bivalves, etc.

Glebe Quarry, E. Kilbride (C.); plants, *Dithyrocaris*, *Sphenopteris*, etc., Calderwood cement-limestone.

Glenboig, 2 m. E. of Garnkirk (C.); cement-limestone in U.L.S.

Glenbuck (C.); old shale-heaps and limestone quarries of L.I. and L.S.

Glencart, 1½ m. E. of Dalry (C.); conodonts, sponge-spicules, gasteropods, bivalves, etc., in cavities in the limestone of U.L.S.

Glenlogan, 4½ m. E.S.E. of Mauchline (C.); U.C.S. and U.L.S.

Glenmore Water, 4½ m. E.S.E. of Cronberry (C.); Cockstail sandstone, etc.

Glenmuir, 3 m. S.E. of Lugar (C.); L.L.S.

Glentagart, 5½ m. S.S.W. of Douglas (C.).

Glespin, 3½ m. S.S.W. of Douglas (C.); U.C.S.

Goldcraig, 2 m. N.E. of Kilwinning (C.); U.L.S.

Goodock Hill, 2 m. N.E. of Omoa (C); pits in U.C.S.

Govan (C.); pits in L.I.S., with *Lepidodendron*, etc.

Gowanlee, 2 m. N.W. of Dalry (C.); sponge-remains, etc., in L.L.S.

Gowkha' Quarry, 1½ m. S.S.W. of Auchenmade (C.); U.L.S.

Gowkhouse Burn, 2 m. W. of Kilbirnie (C.); outcrop of Dalry clayband ironstone, etc., in L.I. and L.S.

Greenhill, 1½ m. N.E. of Omoa (C.); U.C.S.

Greenhill, ½ m. E. of Crosshouse (C.); *Palaeoxyris*, *Pygocephalus*, *Prestwichia*, *Euphoberia*, *Xylobius*, etc., in U.C.S.

Gryfe Water, 1 to 1½ m. E. of Bridge of Weir (C.); L.L.S.

Guelt Water, 5 m. S.E. of Lugar (C.); L.L.S.

Gurdy, Ry. cutting, 1 m. E. of Glengarnock (C.); impure marine limestone and shale, and bed of freshwater ostracoda in L.L.S.

Hag Burn, 1½ m. N.E. of Galston (C.); L.L.S.; *Aviculopecten*, etc.,

Hagshaw Burn, 2 m. S.S.W. of Coalburn (C.); limestone, etc.

Hairmyres, near the station (C); L.L.S.; polyzoa, foraminifera, entomostraca, etc.

Hall Hill, 3½ m. N.E. of Lesmahagow (C.); *Lingula*, etc., in L.C. and I.S.

Hallcraig Bridge, 1¼ m. W. of Carluke (C.); *Lingula* limestone in L.L.S.

Hardcraft, 2 m. N.W. of Dalry (C.); burn-section in U.L.S.

Hareshaw, 2 m. N.E. of Omoa (C.); U.C.S.

Headsmuir, 1½ m. S.E. of Carluke (C.); first calmy limestone in L.L.S.

Heads of Ayr (C.); volcanic debris with blocks of limestone containing fish-remains in C.S.

High Dalblair, 4½ m. S.E. of Cronberry (C.); outlier of L.L.S.

Highfield, 2 m. N.E. of Dalry (C.); U.L.S.; old quarry in Highfield Index limestone.

High Polwhirter, 1¼ m. S.E. of New Cumnock (C.); *Alveolites*, etc., in U.L.S.

High Smithstone, 2½ m. N.W. of Kilwinning (C.); sponge-spicules, bivalves, univalves, etc.; good locality in U.L.S.

Hill, 1 m. S. of Lesmahagow (C.); L.L.S.

Hillhead, 1 m. E. of Carluke (C.); Raes Gill ironstone, and Hosie limestone, in L.L.S.

Hillhead, 3 m. N.E. of Steps (C.); U.L.S.

Hindog Glen, 2 m. N.W. of Dalry; L.I. and L.S.; *Stacheia*, *Valvulina*, *Orthis*, *Platychisma*, etc.

Hole Burn, 6 m. E. of Mauchline (C.); limestone, etc.

Horse Island, off Ardrossan (C.); occasional plants with structure in volcanic debris in C.S.?

Howood, ½ m. N.E. of (C.); *Allagecrinus*, *Syringopora*, etc., in L.L.S.

Howrat, 3 m. N.W. of Dalry (C.); volcanic debris, with fish-remains and *Stigmaria* on top of limestone in L.L.S.; *Solenomya*, etc.

Hullerhirst, 1¼ m. S.W. of Kilwinning (C.); Index limestone, U.L.S.; *Rhynchonella*, *Productus*, *Edmondia*, *Murchisonia*, etc.

Hurlford, pits (C.); U.C.S.

Inkerman, 1½ m. W. of Paisley (C.); pits in L.I.S.

Irvine, pits E. of (C.); U.C.S.

Isle Port, shore section near, 4 m. N.W. of Maybole; conglomerate in (O.R.S.) with derivative fossils in limestone pebbles.

Itlington, 3 m. S.W. of Dalry (C.); U.L.S.

Jerviston, 1½ m. S. of Holyton (C.); U.C.S.

Johnstone, pits N.W. of, (C.); L.I.S.

Jordanhill, 2½ m. W. of Glasgow (C.); shale-heaps of L.I.S.

Keirshill, 1 m. S. of Waterside (C.); old limestone quarry.

Kennox Water, 4 m. S. of Douglas (C.); Gill limestone in U.L.S.; *Cordaites*.

Kerelaw (C.), 1¼ m. N. of Stevenston, Index limestone, etc., in U.L.S.

Kerse Glen, 1½ m. N. of Lesmahagow (C.); L.L.S.

Kersland Glen, 1 m. E. of Kilbirnie, G. & S.-W. Ry. (C.); limestone and shale with *Sanguinolites costellatus*, etc., in L.L.S.

Kilbride, 2 m. W. of Stewarton (C); thick seam of Dalry clayband ironstone; outcrops in L.I.S.

Kilcadzow, 3 m. E. of Carluke (C.); L.L.S.; Raes Gill ironstone; second calmy and main limestones.

Killoch Burn, 3½ m. S.E. of Galston (C.); mollusca, etc., in C.S.

Kilmaurs, burn section, above village (C.); *Nautilus*, *Euomphalus*, etc., in U.L.S.

Kilsyth (C.); pits in L.C. and I.S.; fish-remains, etc.

Kilwinning, pits south of (C.); U.C.S.; *Sigillaria*, *Carbonicola*; abundant fish-remains above Lady Ha' coal.

Kingshaw, 1 m. N.E. of Carluke (C.); second Kingshaw limestone in L.L.S.

Kirktonholm, E. Kilbride (C.); Calderwood cement-limestone and shale, *Adiantes*, etc.

Knightswood, 2½ m. W. of Glasgow (C.); L.C. and I.S.

Laigh Baidland, 2 m. N.W. of Dalry; fish-remains in L.L.S.; *Cochliodus*, etc.

Langhill Point, 2½ m. S.W. of Ayr (C.); fish-remains, entomostraca, plants, etc., shore-section in C.S.

Langshaw, 1 m. S.E. of Carluke (C.); Raes Gill ironstone; second Kingshaw limestone, in L.L.S.

Langshaw Burn, 1 m. S.E. of Carluke (C.); *Lingula* limestone in L.L.S.

Langside, Beith (the late Robert Craig's quarry); L.L.S.

Larkhall (C.); pits in U.C.S.

Law, 2 m. S.W. of Carluke (C.); shale-heaps of U.C.S.

Law, at Cubside, 2½ m. N.W. of Dalry (C.); sponge-spicules, chiton plates, conodonts, gasteropods, bivalves, etc., in L.L.S.

Lee Muir, 1¾ m. S.E. of Carluke (C.); Raes Gill ironstone in L.L.S.

Levenseat, 1 m. from Fauldhouse (C.); limestone and shale.

Lickprivick, 2 m. S.W. of E. Kilbride (C); Calderwood cement-limestone and shale.

Limekilnburn, 1 m. W. of Quarter Road (C.); U.L.S.

Limekilns, near E. Kilbride (C); old shale-heaps.

Linn Spout, 1 m. S.W. of Dalry (C.); a thick bed of Arden cement-limestone, with rich fossiliferous shale under it, and below that a bed with *Estheria*, *Anomia*, *Avicula*, crustaceans, etc., in U.L.S.

Lissens, railway cutting, 1 m. S.W. of Auchenmade (C.); occasional plant-remains showing structure, in volcanic debris in L.C.S.

Little Auchinback, 1 m. S.E. of Barrhead (C.); cement-limestone and shale.

Loans, 1 m. E. of Dalry (C.); thick bed of Arden cement-limestone in U.L.S.

Longlands, 2½ m. S. of E. Kilbride (C.); Calderwood cement-limestone and shale.

Low Dykehead, 2½ m. S.W. of Dalry (C.); U.L.S.

Lucknow, 1¼ m. S.E. of Stevenston (C.); pit-heap, with drifted vegetation in sandstone, *Trigonocarpum*, etc., in U.C.S.

Lugar, pits (C.); a bed of *Lingula* in U.C.S., Crustaceans, *Carbonicola*, etc.

Lugton Water from Auchentiber to near G. & S.-W. Ry. (C.) L.C.S.; U.L.S., and U.C.S.

Lyelston, 3½ m. N.E. of Kilwinning (C.); U.L.S.

Maich Burn, ½ to 1½ m. N.W. of Beith, G. & S.-W. Ry. (C.); L.C.S., L.I.S., and part of L.L.S., with *Carbonicola*, *Lingula*, *Sanguinolites*, etc.

Mansfield Burn, 1½ m. S.S.E. of New Cumnock (C.); U.L.S. with bed of *Productus latissimus*, etc.

Marsh, 3 m. N.E. of Dalry (C.); once a good locality; Index limestone in U.L.S.

Mayfield, 1 m. S.E. of Carluke (C.); shale-heaps of L.L.S.

Mavisbank, 4 m. N.E. of Kilwinning (C.); U.L.S.; abundant crinoid-remains in shale, *Archaeocidaris*, etc.

Meadowfoot, 3 m. E. of Darvel (C.); L.L.S.

Meikle Busbie, 3 m. N. of Ardrossan (C.); plants in C.S.

Middleholm, 2 m. S.W. of Lesmahagow (C.); L.L.S.

Mill Burn, ½ m. N.E. of Lennoxtown (C.); marine and freshwater limestones in L.L.S.

Milton Lockhart, ¾ m. S.W. of Carluke (C.); shale-heaps of L.L.S.

Misk, 1½ m. S.E. of Stevenston (C.); microscopic plants in middletonite in U.C.S. (*Trans. Geol. Soc. Glas.* vol. x. 169 pl.).

Monkcastle Glen, 2½ m. N.W. of Kilwinning (C.); Arden cement-limestone with conodonts, sponge-spicules, etc., in U.L.S.; rich fossiliferous shale under limestone.

Moncur, 1¼ m. E. of Kilwinning (C.); U.C.S. with freshwater entomostraca, and fish-remains.

Morningside (C.); U.C.S.

Mossfoot, 1½ m. N. of Auchinleck (C.); U.C.S.

Motherwell, pits round (C.); U.C.S.

Mount Vernon (C.); *Glyptoscorpius*, etc., in U.C.S.

Mouse Water, 1 to 1½ m. N.N.E. of Wilsontown (C.); L.L.S.; *Vincularia*, *Palaeocoryne*, etc.

Muirburn, 1½ m. S.W. of Stonehouse (C.); L.L.S.

Muirfoot Burn, 1 m. E. of New Cumnock (C.); estuarine shales, etc., in U.L.S.

Muirkirk (C.); pits in L.C.S.

Nellfield Burn, 2 m. S.E. of Carluke (C.); L.L.S.

Nethan Water, at Auchenheath (C.); old shale-heaps of L.L.S.

Nethercraigs, 2 m. S.S.W. of Paisley (C.); L.L.S.

Netherfield, 1 m. E. of Strathavon (C.); L.L.S.; *Zaphrentis*, etc.

Netherhouses, 1 m. S. of Caldwell (C.); shale-heaps from L.I.S.

Netherton, near Caldwell (C.); shale-bings from L.I.S.

Nettlehirst, near Giffen (C.); large entomostraca in upper bed of L.L.S.; lower bed worked in a quarry; corals, etc.

Newarthill (C.); shale-heaps of U.C.S.

Newfield, 1 m. S.W. of High Blantyre (C.); old shale-heaps from cement-limestone quarry and mine; polyzoa abundant; *Hydreionocrinus*, ? *Edmondia*, *Pecten*, etc.

Newhouse, 1 m. N.W. of Dalry (C.); L.L.S.

Newmains (C.); coal-pits in U.C.S.

Newton (C.); coal-pits in U.C.S.
North Brae, 1 m. S.E. of Barrhead (C.); U.L.S.
Ochiltree, Burnock Water; *Spirorbis* limestone in the drift.
Old Cumnock (C.); pits and river-sections near ry. station, in U.C.S.; *Anthracomya*, etc.
Old Mill, 1½ m. N.W. of Lugton (C.); L.L.S.
Orchard (C.); old shale-heaps with holothurian-remains, *Platycrinus*, Univalves, Bivalves, etc., in U.L.S.
Paduff Burn, 2 m. W. of Kilbirnie (C.); L.L.S.; *Productus giganteus* in living position, etc.
Palace Craig (C.); shale-heaps of U.C.S.; *Estheria*.
Patna, pits near (C.); L.C.S.
Penbreck, 5½ m. S.S.E. of Muirkirk (C.); outlier of U.L.S. and L.L.S., the former with rich fossiliferous shale.
Penyvenie Burn, 1½ m. N.E. of Dalmellington (C.); U.C.S. capped by trap.
Pitcon Burn, 2 m. S.W. of Kilbirnie (C.); shales, limestones and ironstones, in L.L. and I.S.
Plan, near Crosshouse (C.); heaps from coal and ironstone workings in U.C.S.
Polbaith Burn, 2½ m. N. of Galston (C.); L.L. and I.S.; *Posidonella*, *Lingula*, etc.
Polquheys, 1½ m. N. of New Cumnock (C.); U.L.S.; corals, etc.
Polwhannan Burn, 3½ m. S.S.E. of Muirkirk (C.); *Melonechinus*, *Productus giganteus* (small var.), holothurian-remains, etc., in outlier of L.L.S.
Possil, N. side of Glasgow (C.); old shale-heaps of L.C. and I.S.; *Rhizodus*, *Lepidodendron*, *Lingula*, etc.
Powmillan Burn, ¼ m. E. of Strathavon (C.); rich fossiliferous shale.
Provanhall, 3 m. N.E. of Glasgow (C.); pits in U.C.S.
Pundeavon Burn, 1¼ m. N.W. of Kilbirnie (C.); outcrop of Dalry clayband ironstone, *Lingula* shale, and limestone in L.I. and L.S.
Quarter, 1 m. from Quarter Road (C.); old shale-bings of U.I.S.; *Anthracoptera*, *Callopristodus*, *Eyracanthus*, *Harpacodus*, *Amphicentrum*, etc.
Raes Gill, 2 m. W. of Carluke (C.); *Volkmania*, *Pteroplax*, *Palaeoniscus*, *Deltodus*, *Lingula* limestone; first calmy limestone, Raes Gill ironstone, and Hosie limestone, in L.L.S.
Rankinston (C.); *Carbonicola*, plants, etc., in U.I.S.
Rankinston Glen, E. of ry. station (C.); *Anthracite* and free coals in U.C.S.; great trap sill.
Robroyston, 2 m. E.S.E. of Bishopbriggs (C.); old shale-heaps of U.L.S.
Roughwood, 1 m. S. of Beith, Cal. Ry. (C.); bed with *Naidites*, *Cyclophyllum*, *Rhodocrinus*, *Spirorbis*, *Amplexus*. etc., in L.L.S.
Rutherglen (C.); pits in U.C.S.; *Cyclopteris*, *Sphenophyllum*.
Rye Water, S. slope of Hindog glen (C.); shale and limestone of U.L.S.
Rye Water, escarpment on N. side, 1½ m. N.N.W. of Dalry (C.); foraminifera abundant in shale in U.L.S.
Rye Water, a little further down than last, and nearly opposite Ryefield; fossils in bed of stream in U.L.S.
Saltcoats (C.); U.L.S. and U.C.S. on the shore; bed of *Productus latissimus* in the former.
Sculliongour, 1 m. N. of Lennoxtown (C.); shale-heaps.
Shettleston (C.); pits in U.C.S.
Shielburn, near Benthall (C.); L.L.S.; 2½ m. S. of E. Kilbride.
Shotts (C.); pits in U.C.S.; *Pinularia*, *Carbonicola*, *Favularia*, *Sigillaria*, etc.
Skaterigg, 2½ m. W. of Glasgow (C.); L.C. and I.S.
Skitridge Gill, 2 m. S. of Carluke (C.); "maggy" ironstone in U.L.S.
Sorn, 4 m. E. of Mauchline (C.); old shale-heaps and river-sections on Ayr Water in U.L.S.
South Biggart, 1 m. W. of Lugton; L.L.S.; *Saccammina*, etc.

South Hill, 1 m. S.W. of Lennoxtown (C.); shale-heap of L.I.S.
South Shields, 2 m. S.W. of E. Kilbride (C.); L.L.S.; *Vincularia*, *Petalorhynchus*, etc.
Springhill, (C.); shale-heaps of U.C.S.
Stacklawhill, 3½ m. S.W. of Stewarton (C.); U.L.S.; *Murchisonia*, *Nodosaria*, bivalves, ostracoda, etc.
Stanrigg, Airdrie (C.); U.C.S.; *Palaeostachya*, *Renaultia*, *Urnatopteris*, etc.
Stevenston (C.); pits, *Prestwichia*, *Carbonicola*, *Halonia*, *Lyginodendron*, *Trigonocarpum*, etc., in U.C.S.
Stewarton, sections on Annick Water, (C.); L.L.S.
Swansie Burn, 2½ m. N.E. of Stewarton (C.); L.L.S.
Swindridgemuir, 3 m. N.E. of Dalry (C.); *Dentalium*, *Naticopsis*, *Euomphalus*, *Loxonema*, *Murchisonia*, *Macrocheilus*, etc.
Swinhill, 1¼ m. N. by E. of Stonehouse (C.); U.C.S.; with *Cardiocarpon*, *Megalichthys*, etc.
Swinlees, old quarry, 3 m. N.W. of Dalry (C.); foraminifera and *Melonechinus* plates abundant in the shale; L.L.S.; *Favosites*, *Heterophyllia*.
Swinlees Glen, 3 m. N.N.W. of Dalry (C.); L.I.S.
Teiglam Burn, 1 m. N. by W. of Lesmahagow (C.); L.L.S.; *Aviculopecten*.
Thirdpart, 2½ m. N.W. of Dalry (C.); L.L.S.
Thorn, 1 m. N.E. of Carluke (C.); *Archaeocidaris* in disjointed masses in nodules in L.L.S.
Thornliebank (excavations now closed), rich in fossils, *Conularia*, *Goniatites*, etc., (C.)
Thornton, quarry near Eaglesham Road (C.); limestone, oolitic nodules, oil-shale, volcanic ash-bed, etc.; reptilian remains, etc.; *Leda* in L.L.S.
Tibby's House (ruin) 1 m. W. of Muirkirk; rich shale, *Fenestella*, etc.
Tillietudlem, pit heaps near (C.); shales from "Lesmahagow" gas-coals in L.I.S.
Tirfergus Glen, near Campbeltown (C.); L.L.S.
Torrance Glen, near E. Kilbride (C.); L.L.S.
Torry Glen, Chapelhall (C.); shale with fish-remains in U.C.S.
Troon, S. side of peninsula (C.); Water-of-Ayr hone-stone bed, with occasional plants, in U.C.S.
Tulloch, 2 m. S.E. of Darvel, (O.R.S.), with *Cephalaspis*.
Twechar, pits near (C.); L.C. and I.S.
Wallaceton, 1 m. N.E. of Dailly (C.); railway section, shales, coals, and limestone, in U.L. and L.C.S.
Warwickhill (C.); pits near Springside in U.C.S.
Waterland, near Lugton (C.); quarry- and burn-section in L.L.S.; volcanic ash on top of limestone, with fish-remains and *Stigmaria* roots; *Cardiomorpha* and *Poterioceras*.
Watston, 1 m. S.E. of Stonehouse (C.); U.C.S.; *Sphenopteris*, fish-remains, etc.
Waukmill, 1½ m. E. of Strathavon (C.); sections on Avon Water in L.L.S.
Waukmill Glen, 1½ m. E.S.E of Barrhead (C.); *Cyrtoceras*, *Nucula*, *Leda*, etc.
Waygateshaw, 1¼ m. S.S.W. of Carluke (C.); first calmy limestone and Raes Gill ironstone in L.L.S.
Wemyss Bay (C.); *Helminthites* tracks (?) in sandstone in C.S.
Westerhouse, 3 m. N.N.E. of Carluke (C.); Gare limestone; once a good locality, but heaps now grassed over, U.L.S.
West George Street, Glasgow (C.); in founds for houses, etc.; U.L.S.
West Kilbride, railway section (C.); footprints, etc., on sandstone in C.S.
Whatriggs, 2 m. N. of Galston (C.); L.L.S.
Whitecleuch, 7 m. N.N.E. of Sanquhar (C.); outlier of L.L.S.
Whiteinch, W. of Glasgow (C.); fossil trees in Victoria Park.
Whitehill, near Airdrie (C); *Megalichthys pygmaeus*, etc., in oil-shale in U.C.S.

Whiteshaw Bridge, 1 m. W. of Carluke (C.); burn-section in U.L.S.
Whitespot, railway section between Giffen and Glengarnock (C.); *Naidites* bed above a coal-seam in L.C.S.
Wildshaw, 5 m. S.E. of Douglas (C.); outlier of L.L.S.
Wilton, 1 m. S. of Carluke (C.); shale-heaps from Raes Gill ironstone in L.L.S.
Wishaw (C.); *Sigillaria*, etc., in U.C.S.
Woodhill, ½ m. E. of Crosshouse (C.); U.C.S.; *Prestwichia*, *Belinurus*, etc. (Mammoth remains were got in the "bare" of the quarry.)
Woodside Pits, W. of Glasgow, 1837 (C.); *Tristychius.*
Yuildshiels, 2 m. E. of Carluke (C.); burn-section in L.L.S.

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